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THE ROENTGENOGRAPHIC IMAGE OF NEOPLASMS OF BONE[1]

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WITH the advent of roentgenology, in 1896, came the opportunity to study pathologic changes in the living individual. The application of this new science to the study of anatomy established new conceptions of the normal and its limit of variation. Roentgenology opened an entirely new field of investigation by affording a graphic record of the life history of pathologic processes.

Many careful and critically discerning studies were made by the pioneers in the new science, and roentgenologic, clinical, surgical, and anatomic-pathologic findings were correlated. The facts established by these studies were registered by publication in books and in original articles in scientific journals, and thus were made available to the members of the medical profession at large.

The appreciation of the value of the roentgenogram in the study of neoplasms of bone has been heightened in recent years by the enhancement of the brilliancy of its detail. This has been the result of improvements in machinery and accessories, and refinements in technic, which have been developed largely in the research laboratories of universities and great industrial establishments. The commercial possibilities associated with the development of the new science have always assured it liberal endowment.

The roentgenogram of to-day, if the technic is adequate, presents as accurate evidence of a given lesion as does the microscopic section. The knowledge of this fact, as it has gained general recognition, has shifted an ever-increasing responsibility on the roentgenologist. The patient with any lesion which involves a bone or joint is sent for roentgenographic examination, frequently before the general examination, and the fate of the patient often rests on the interpretation of the roentgenographic image. A false conclusion might influence further investigation sufficiently to establish an erroneous diagnosis, and in some cases it even might result in therapeutic measures which would prove tragic.

The question uppermost in the minds of the referring physician and the patient is whether or not there is a lesion of the bone, the joint, or the contiguous soft tissues, and if there is, is the lesion inflammatory or neoplastic in nature? If it is neoplastic, is it benign or malignant, and if it is malignant, is it primary or metastatic?

To solve these questions one turns to the accumulated evidence to be found in publications, and compares the findings in individual lesions recorded there with those of his own experience that have been biopsied or surgically treated and proved by micro-

[1] Read before The Radiological Society of North America, at the Twenty-first Annual Meeting, in Detroit, Dec. 2–6, 1935.

scopic examination of tissue, to find if there are features of the roentgenographic image by which the inflammatory lesion in bone may be differentiated from the neoplastic and the benign neoplasm from the malignant. If the neoplasm is malignant, it is necessary to determine whether there are any features of the roentgenographic image by which one can distinguish the primary tumor of bone from the secondary or metastatic malignant involvement of bone.

In benign lesions of bone, the continuity of the contour shadow is maintained; it may be distorted or expanded, but it remains intact. In malignant lesions of bone there is a dissolution of the contour shadow. Where the contour shadow is not involved by the lesion, that is, in the os innominatum, the margin of the filling defect which is created in the bone by the tumor is irregularly serrated or almost imperceptible if the lesion is malignant, and is smooth and well defined if the lesion is benign. When the tumor breaks through the contour shadow and invades the contiguous soft tissues, the outline of the invading mass is not discernible or is at least poorly defined, if the lesion is malignant, whereas, if the lesion is benign, the margins of the invading tumor are definitely demarcated.

With this foundation, one may go further and differentiate the various forms of benign and malignant tumors by varying features of their roentgenographic images.

To facilitate the consideration of the individual lesions, I have adopted a modification of the classification chosen by the American Registry of Bone Sarcoma in 1923, in collaboration with the committee appointed by the Clinical Pathological Association (Table I.)

Metastatic malignant tumors arise from implantation of cells or cellular emboli from neoplasms situated in other tissues of the body, and have the histologic characteristics of the parent growth. The osteoclastic form is most frequently seen, secondary to carcinoma of the breast; it is the usual form seen secondary to carcinoma of the kidney, suprarenal glands, lungs, thyroid gland, uterine cervix, or ovaries, and frequently follows melano-epitheliomas. The conformation of the roentgenographic image of this form suggests melting ice. The lesions may be localized in one or more bones, or there may be a general involve-

TABLE I.—TUMORS OF BONE

I. Metastatic tumors
  (*A*) Osteoclastic forms
  (*B*) Osteoplastic forms
  (*C*) Multicentric growth of osteogenic sarcoma
  (*D*) Lymphosarcoma
II. Osteogenic tumors, malignant type (osteogenic sarcoma)
  (*A*) Subperiosteal and medullary sarcoma
  (*B*) Periosteal sarcoma
  (*C*) Sclerosing sarcoma
  (*D*) Telangiectatic sarcoma (aneurysm of bone)
  (*E*) Chondrosarcoma
  (*F*) Atypical forms
III. Inflammatory conditions simulating malignant lesions of bone
  (*A*) Osteoperiostitis
    (1) Traumatic (chronic sclerosing osteitis)
    (2) Infectious (nonsuppurating osteomyelitis of Garré)
    (3) Syphilitic
  (*B*) Osteomyelitis
    (1) Traumatic
    (2) Infectious
    (3) Tuberculous
  (*C*) Traumatic osteoma of long bones
    (1) Subperiosteal hematoma (intact or ruptured)
    (2) "Rider's" bone
    (3) Pseudo-osteoma (localized collections of osteophytes)
    (4) Heterotopic bone
  (*D*) Traumatic osteoma at joints
  (*E*) Simple solitary cysts of bone
IV. Non-inflammatory conditions simulating malignant lesions of bone: Osteitis deformans (Paget's disease)
V. Ewing's tumor (Ewing's sarcoma)
VI. Malignant lesions simulating benign neoplasms of bone
  (*A*) Periosteal fibrosarcoma (extra periosteal sarcoma)
  (*B*) Myeloma
VII. Osteogenic tumors, benign type (osteochondroma)
  (*A*) Chondroma
  (*B*) Fibroma
  (*C*) Osteoma
VIII. Non-inflammatory conditions simulating benign lesions of bone
  (*A*) Osteodystrophia fibrosa (osteitis fibrosa)
    (1) Localized osteitis fibrosa
    (2) Osteitis fibrosa cystica generalisata (von Recklinghausen's disease)
  (*B*) Biotrophic osteoma (exostosis)
    (1) Cauliflower type with pedicle
    (2) Flat type with broad base
  (*C*) Diaphyseal or metaphyseal aclasis (multiple congenital exostosis; chondrodysplasia)
  (*D*) Osteomalacia
  (*E*) Generalized xanthomatosis of bone (Hand-Schüller-Christian syndrome)
IX. Giant-cell tumor
X. Angioma (benign and malignant)

ment of the whole or the greater part of the skeletal structure. Involvement below the knees or elbows is rare; when it does occur, there may be extensive destruction of a single bone, such as the radius, ulna, tibia, or fibula. The localized lesion presents the most perfect picture of the malignant lesion in bone; there is a sudden dissolution of the contour shadow, and the filling defect in the bone exhibits an irregular or serrated marginal outline, or fades imperceptibly into the normal bone shadow. The neck and upper part of the shaft of the femur, the upper part of the shaft of the humerus, the bodies of the vertebræ, and the ilium are the most frequent sites of the isolated lesions. In the first three, pathologic fracture is not uncommon, and may be the incident which calls attention to the metastatic involvement. Extensive destruction of the bodies of the vertebræ has been observed at necropsy in cases in which little or no evidence of the lesion was apparent in the roentgenogram. One, therefore, must assume that compression of the body of the vertebra had its origin in pathologic fracture. This observation also suggests that definite clinical evidence of metastasis to bone cannot be disregarded when roentgenographic findings fail to reveal such metastasis. It is often difficult to definitely establish the presence of localized metastatic malignant lesions in the ribs. When osteoporosis of bone and some accentuation of the bronchovascular markings of the lung occur in cases in which the patients are past middle age, superimposition of the shadow of the fibrous lung on the lessened density of the shadow of the bone will create pseudo-defects in the bone. In all cases of doubt, re-examination with a heavier exposure and the interposition of the Potter-Bucky diaphragm will eliminate the pulmonary shadows, heighten the detail of the bone, and establish or refute the diagnosis.

The osteoplastic form of metastasis is characterized by an increase in the density of the bone; this form usually occurs secondary to carcinoma of the prostate. A somewhat different form of osteoplastic metastasis is seen secondary to carcinoma of the stomach, and in rare cases in which metastasis of carcinoma of the breast may produce osteoplastic involvement of bone. In carcinoma of the prostate, the metastatic lesions may be localized or intermittently distributed, or there may be a general involvement of the skeletal structure. The lesion frequently involves the inner margin of the ilium on one side first, and may spread throughout a single os innominatum before it becomes apparent in other parts. Not infrequently, the first evidence is in the innermost margins of both ilia, under the overlying lateral wings of the sacrum, and may be misinterpreted as hypertrophic arthritis. The distribution in many cases is very erratic. It is not uncommon to see single vertebræ, involved in various segments of the spinal column, with one or several intervening uninvolved vertebræ. There may be small splashes of proliferation of bone on a background of normal bony shadow, this producing the "spotted" type of roentgenographic image. In the general involvement there is a marked deepening of the density of the bone throughout the skeletal structure, excepting the cranium.

The roentgenographic characteristic of the osteoplastic metastasis of carcinoma of the prostate is a background of intense destruction of bone; superimposed on this is evidence of extensive proliferation of bone. The proliferation of bone usually keeps pace with the destruction of bone; in the individual case, there may be a variation in the predominance of one or the other factor, and the image may vary slightly. The average picture is that of a coarsely granular shadow of heightened density, in which there is no evidence of the bony trabeculæ. In metastasis of carcinoma of the stomach and, as stated, rarely in the metastasis of carcinoma of the breast, the sclerotic regions tend to be homogeneous in density and are not uniformly distributed; the whole image is more "splotchy" than that of the metastasis of carcinoma of the prostate.

Lesions in bone which are analogous to metastasis, are seen in cases of osteogenic

carcinoma in other parts of the skeleton. Many observers believe that these are multicentric growths. Involvement of bone is seen in a proportion of cases of lymphosarcoma or Hodgkin's disease, but the roentgenographic appearance is similar to that of a primary lesion of bone, although osteoclastic and osteoplastic changes are not infrequently seen which are very similar to those of metastatic involvement.

The word "osteogenic" is derived from the Greek words which signify "to produce bone," but in this classification it includes tumors which arise from bony cells, and which retain more or less of the function of production of bone, in contradistinction to those which arise from bone marrow. The malignant osteogenic tumors are grouped under one term, "osteogenic sarcoma," but subdivisions of these have individual characteristics by which they may be recognized roentgenographically. The subperiosteal and medullary sarcomas have the features of a localized malignant metastatic lesion. There is an abrupt dissolution of the cortical contour shadow, a "melted ice" type of filling defect in the bone, and a homogeneous shadow invades and passes imperceptibly into that of the contiguous soft tissues. The periosteal sarcoma exhibits an elevation of the periosteum just above the site of the dissolution of the contour shadow of the cortex, a definite denuding of the cortex over the site of involvement, and a promiscuous invasion of the adjoining soft tissues. In some cases, myriads of small bony spicules radiate to the shaft of the bone in a manner which gives a "sun-ray" effect to the whole picture. In these cases the other mentioned characteristics may be overshadowed or entirely absent. The sclerosing sarcoma presents an eburnation of the involved bone, with the dissolution of the cortical contour shadow and the promiscuous distribution of the bony invasive shadow into that of the surrounding soft tissues. The telangiectatic sarcoma, or aneurysm of bone, has many of the features of the osteoma in the roentgenogram. Usually, there is an extensive bony proliferation at the side of the tumefaction; a projection at a right angle will throw the cortical contour shadow into relief and reveal a promiscuous invasion of the soft tissues. The chondrosarcoma may arise primarily in the bone, but it not infrequently begins as a chondroma or osteochondroma. In the latter case the cells apparently undergo a mutation, and the tumor remains more or less dormant for a varying period and then suddenly commences to increase in size. In both types, one may have to search very carefully for evidence of the dissolution of the cortical contour shadow and the promiscuous invasion of the soft tissues. Cartilage offers little or no resistance to the passage of the roentgen rays; therefore, it is difficult to recognize the margin. With a strong light focused behind the roentgenogram, and with a magnifying glass, which, incidentally, is an excellent way to study all tumors, the malignant tumors will show definitely a promiscuous invasion of the soft tissue shadow.

The usual situation of an osteogenic sarcoma is in the diaphysis; the epiphysis usually is not involved primarily, but it may be by extension. Osteogenic sarcomas which involve the shaft of bone often produce an atypical roentgenographic image. I have seen several which have had all the characteristics of Ewing's tumor, and which proved, on microscopic examination and radiotherapeutic tests, to be osteogenic sarcomas. Other osteogenic sarcomas may simulate chronic sclerosing osteitis or nonsuppurating osteomyelitis of Garré, which in my experience are indistinguishable from each other roentgenographically, more closely than they do Ewing's tumor. All of these may be difficult to differentiate at times in the roentgenogram. Syphilitic osteitis may simulate sclerosing osteogenic sarcoma very closely; the diagnosis will rest on careful inspection for promiscuous invasion of the soft tissues and dissolution of the cortical contour shadow. Osteomyelitis of the traumatic or infectious type frequently simulates or is a factor of error in the diagnosis of Ewing's tumor, but it occasionally may simulate osteogenic sarcoma.

Tuberculous osteomyelitis, which is characterized by a lack of reaction in the margins of the bony defect, has been mistaken for osteogenic sarcoma. If there are sinuses, the margins of these are always smooth, and collections of caseous material in the surrounding soft tissues can always be visualized as definitely outlined. In tuberculosis of joints, the intense demineralization of the bone, which is a feature of this disorder, may simulate a dissolution of the cortical contour shadow and a malignant filling defect in the bone. Tuberculosis usually involves all the bones in the vicinity of a joint, for example, both condyles of the femur and both tuberosities of the tibia in the region of the knee joint.

Of the traumatic osteomas of long bones, the subperiosteal hematoma, particularly the ruptured form, may simulate very closely some of the atypical forms of osteogenic sarcoma which involve the shaft of the femur. In a ruptured subperiosteal hematoma, the spicules of bone that radiate from the shaft do not produce the same definite formation that they do in an osteogenic sarcoma, and the "sun-ray" effect is not the same. The other subdivisions listed in the classification seldom can be mistaken for malignant lesions. In simple solitary cysts of bone, the filling defects usually have smooth margins, and at any angle the continuity of the contour shadow of the cortex will always be maintained.

Osteitis deformans (Paget's disease) has in my experience been difficult to differentiate from carcinomatous osteitis secondary to carcinoma of the prostate. Both affect men who are in the same period of life, and both are frequently incidental findings in routine examination. Benign osteitis has many of the characteristics of osteoplastic metastasis. I have seen a comparatively large series of cases in which osteitis involved a single os innominatum. A coincidental secondary anemia has been noted in carcinomatous osteitis, as it has been in the apparently benign forms of sclerosing osteitis. It has not been possible to demonstrate carcinoma of the prostate by physical examination in some cases in which the roentgenographic evidence of the lesion was almost pathognomonic. The differential points which I have noted are as follows: In the benign osteitis, or osteitis deformans, the evidence of the trabecular elements is maintained or accentuated; in carcinomatous osteitis it is always obliterated. In osteitis deformans, there is an enlargement of the shadow of the bone as a result of subperiosteal deposition of bony tissue; in carcinomatous osteitis, there is no enlargement of the bony shadow. In cases of osteitis deformans in which the femurs are involved, there is widening of the cortex of the femur and bowing of the shaft; this feature is absent in carcinomatous osteitis. Where there is doubt as to the nature of the lesion, roentgenographic examination of the cranium and the tibiæ will serve to corroborate the diagnosis if the lesion is osteitis deformans (Paget's disease). Roentgenographic examination should always include a roentgenogram of the pelvic bones and the upper ends of the femurs.

In the roentgenogram, Ewing's tumor (Ewing's sarcoma) is frequently confounded with osteomyelitis. The pathognomonic sign of Ewing's tumor is an elliptic expansion of the middle third of the shaft of the bone, most frequently the femur, the outer edge of which shows a series of laminations of bone, running parallel to the shaft, which has been described as an "onion-skin" layer. Various modifications of this formation are observed. There may be an elevation of the periosteum for a short space, and above this, short spicules of bone may project horizontally at right angles to the shaft and all in the same plane. In the medullary portion of the bone, a ground glass or fibrous background may show multiple regions of lessened density, which suggest necrosis very similar to that observed in roentgenograms of early osteomyelitis. The periosteal proliferation resembles in many respects the involucrum seen in cases of advanced osteomyelitis, and it is interesting that in some cases of Ewing's tumor a periosteal shell, which is even more extensive than is that in the average

case of osteomyelitis, develops after roentgenotherapy. In several cases in which the patients were seen at the Clinic before the discovery of Ewing's tumor, the pathologic report was round-cell sarcoma, and in one case in which the tissue had been examined elsewhere, the pathologic report was small-cell sarcoma. In all of these cases roentgenotherapy had resulted in the creation of a wide shell of bone over the involved region, and a re-examination of the tissue in several of these cases showed that the lesions were Ewing's tumors. In cases in which the tumor has broken through this periosteal defense, the shadow of the invasive portion is indefinitely outlined; it does not show the sharply demarcated outline of the benign tumor, or has it any of the promiscuous character of the osteogenic sarcoma. In the pelvic bones, the filling defect has the roentgenographic appearance of the malignant tumor, and, in cases in which the tumor extends beyond the line of the cortex, its shadow has the same indefinite outline that I have already described. There is often difficulty in the differential diagnosis of chronic sclerosing osteitis and the nonsuppurating osteomyelitis of Garré. In some cases, the intact form of subperiosteal hematoma has many of the characteristics of Ewing's tumor.

Periosteal fibrosarcoma (extraperiosteal sarcoma) involves bone by pressure erosion, and the filling defect is commonly smooth margined, resembling in this respect that of the benign tumor. In some cases it may simulate very closely the roentgenographic appearance of the giant-cell tumor.

Myeloma in its roentgenographic appearance violates all the rules that are laid down for the recognition of the malignant type of lesion, with the exception, perhaps, of the general involvement which may be almost indistinguishable from the osteoclastic form of metastatic carcinoma. In the clavicle, the humerus, and the rib, expansion of the shaft without evidence of any dissolution of the cortical contour shadow has been observed, and microscopic examination of excised tissue has proved that the lesion was a myeloma. In the skull and humerus, discrete defects in the bone are observed; these have such smooth margins that they appear to have been made by a steel punch.

The benign osteogenic tumors are classified under the heading of osteochondroma and may be subdivided, roentgenographically, according to the preponderance of the cellular element in the individual tumor, into chondroma (cartilage), fibroma (fibrous tissue), and osteoma (bone). In these tumors, one has the personification of the benign tumor in the roentgenogram in the smooth margin of the filling defect in the bone, the lack of any dissolution of the cortical contour shadow, however extensive, may be the expansion or distortion of the bone by the tumor, and the continuation of definite encapsulation when the tumor invades the surrounding soft tissues.

Localized osteitis fibrosa (osteitis fibrosa cystica) exhibits the roentgenographic features of a chrondroma, usually in the shaft of a bone, but not infrequently the shadow shows a multicystic formation. Osteitis fibrosa cystica (fibrocystic disease) may involve a considerable portion of the shaft of a bone, and in the roentgenogram it has many of the characteristics of the giant-cell tumor, but usually involves a wider area and retains its multicystic image more definitely.

Osteitis fibrosa cystica generalisata (von Recklinghausen's disease) is now generally accepted as one form of bony involvement in parathyroid disease. Roentgenographically, it exhibits a generalized multicystic condition of nearly all the bones of the skeleton, with thinning and expansion of the cortex. Pathologic fractures of the bones are frequent. Definite biochemical changes and a complex of symptons in association with the roentgenographic findings are necessary to the confirmation of the diagnosis.

Biotrophic osteomas (exostoses) have the roentgenographic characteristics of the osteochondroma. They originate as ossifications in the tendons and extend in the direction of the tendon, which is usually

away from the joint. They are looked on as congenital in origin, an abnormal attribute of normal growth. In their earlier stages they are capped by hyaline cartilage. Two forms are distinguishable: (1) the flat exostosis with a broad base of bone, crowned with a comparatively thin layer of cartilage, and (2) the cauliflower exostosis, with a thin stem of bone and an expanded cap of cartilage.

Diaphyseal or metaphyseal aclasis (chondrodysplasia) has been more generally recognized as multiple congenital exostosis. It is characterized in the roentgenogram by multiple, often symmetrically distributed, exostoses, which arise from both sides of the shaft of a bone a short distance above the epiphyseal line. All the bones of both extremities may be involved, and exostoses may occur in the ribs and vertebræ. Deformities may result from interference with growth and disproportionate development of one of the bones in the forearm or leg. In the majority of cases the projections are bony, but not infrequently these have cartilaginous caps expanding in a cauliflower fashion.

Osteomalacia exhibits a general thinning of the cortex and marked osteoporosis of the bone, but has little in its roentgenographic image to suggest any form of tumor.

Xanthomatosis is a skeletal lipoid granulomatosis which attacks by preference the vault of the skull, the bones of the pelvis, ribs and vertebræ, the scapula and the long bones. The cranium in the roentgenogram exhibits large, smooth-margined filling defects of various sizes in the bone. Where the contour shadow is brought into relief, it shows no evidence of dissolution. The base of the skull is involved, and the sella frequently is destroyed. In the other bones mentioned there are multiple cystic rarefactions which extend to the compact bone, but, as in the cranium, there is no dissolution of the cortical contour shadow. The roentgenographic image in the long bones is not unlike that of localized osteitis fibrosa cystica. The cysts are usually in the diaphysis, but may involve the epiphysis. There is no alteration of the bony architecture other than some expansion of the shaft, and there is no disturbance of growth. Sclerosis of the bone has been reported in cases in which healing has occurred.

In some stages of giant-cell tumor, the roentgenographic image typifies a benign tumor more accurately than does the image of almost any other tumor. In other stages, the image simulates the malignant tumor so closely as to require careful study to avoid serious error. The tumor appears commonly in the epiphysis of a long bone, but may involve the entire diaphysis above the epiphyseal line. It expands the cortex, and roentgenographically exhibits a clear background with a superimposed network of fine trabeculations. The cortex may be expanded and thinned to the extent that its outline is not discernible in the roentgenogram, and the tumor may invade the surrounding soft tissues, and the outline of the invasion shadow may be difficult to trace. In this invasive type, the anteroposterior view usually will reveal a small undulating wave of ossification, which passes out from the shaft of the bone over the shadow of the invading soft tissue. A lateral view will show the intact contour shadow of the shaft projected for some distance into that of the tumor. The filling defect in the bone is usually smooth-margined, but it occasionally may be irregular and even serrated.

Angiomas of bone are rare in my experience. The benign form has been seen involving the body of a single vertebra. The roentgenographic image consists of a series of coarse striations running vertically on a background of diminished density of the remainder of the body of the vertebra. There may be compression of the body of the vertebra. The roentgenogram of the malignant form exhibits very extensive destruction of the whole shaft of the ulna, similar to that seen in osteomyelitis; with increased density of the bone, it reveals marked proliferation of the periosteum and intensive hypertrophy of the soft tissue. An apparent invasion of the surrounding soft tissues may reveal an outline that has

an indefinite character which is peculiar to that of Ewing's tumor.

In presenting these roentgenographic images I have avoided, wherever possible, any reference to clinical or other data. In my experience, the making of a primary roentgenographic interpretation, or diagnosis, without knowledge of any of the clinical or other data, and with subsequent correlation of the roentgenographic and the subjective and objective findings of the clinical examination, has proved the most satisfactory method of studying lesions in bone. A co-operative interest of the clinician and the roentgenologist in the findings in cases in which surgical treatment offers the opportunity of microscopic examination of tissue, or in the end results in cases in which radiotherapy is the method of treatment adopted, tends to heighten the appreciation of each of these respective diagnostic methods. Both are indispensable methods of diagnosis; each is entirely dependent on the other, and only by close co-operation in correlation of all the findings can the best interests of the patient be served.

ROENTGENOLOGIC CHANGES IN MALACIC DISEASES OF BONE[1]

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THE past several years have witnessed the accumulation of a voluminous literature concerning malacic diseases of bone, particularly hyperparathyroidism. This was stimulated largely by the report of Mandl (1), in 1926, of a case of osteitis fibrosa cystica generalisata (von Recklinghausen's disease), in which the removal of a parathyroid adenoma was followed by prompt clinical improvement. Since that time, the existence of "hyperparathyroidism" as a definite clinical entity has become well established. Because of the profound influence of the parathyroid glands on the fundamental metabolism of calcium, and probably of phosphorus, it is not surprising that the question of parathyroid function, as related to other forms of malacic disease of bones, the origin of which is supposedly known or unknown, has been seriously considered. Some enthusiastic investigators see in hyperparathyroidism a ready explanation for the cause of such conditions as osteitis deformans (Paget's disease), leontiasis ossea, ankylosing polyarthritis of Oppel, giant-cell tumor, multiple myeloma, and scleroderma. Others are less ready to accept such a broad application of the term "hyperparathyroidism." Because of such conflicting opinions, no little confusion has resulted, particularly in the minds of roentgenologists, concerning the identity of certain forms of malacic disease of bone. Without doubt, the present intensive clinical and investigative work that is being carried out on the subject of hyperparathyroidism and mineral metabolism in general will have a far-reaching effect on our knowledge and classification of certain lesions of bone.

The problem is not an easy one, for it involves not only the intricate biochemistry of mineral metabolism, but also the function of the ductless glands and the complexities of their interrelated activities. With a full realization of this situation, the classification in Table I is offered, subject to revision. It does offer, at the present time, however, a reasonable basis for a discussion of the roentgenologic changes in the various forms of malacic diseases of bone.

TABLE I.—CLASSIFICATION OF MALACIC DISEASES OF BONE

Atrophy associated with	
Disuse	Neurotrophic disorders
Fractures	Circulatory disorders
Arthritis	
Congenital defects	
Osteogenesis imperfecta	
Fragilitas ossium	
Dietary insufficiency and avitaminosis	
Rickets	
Osteomalacia	
Puerperal	Celiac disease
Senile	Chronic idiopathic steatorrhea
Hunger and war deficiency	
Renal insufficiency	
Renal dwarfism	
Renal rickets	
Endocrine malfunction	
Hyperparathyroidism	Suprarenal disease
Hyperthyroidism	Pancreatic disease
Cushing's syndrome (Basophilism)	Diabetes mellitus
	Carcinoma
	Pancreatitis
Miscellaneous: Etiology unknown	
Focal osteitis fibrosa cystica	
Osteitis deformans (Paget's disease)	

Because of the multiplicity of conditions that may affect the mineral content and structure of the skeleton, the early recognition of any particular disease by roentgenograms alone may be exceedingly difficult. Even in some advanced lesions, as will be pointed out subsequently, the ultimate diagnosis can be made only by proper correlation of the clinical data and other laboratory findings.

ATROPHY

Atrophy of bone, which results from disuse incident to trauma, fracture, arthritis, neurotrophic disorders, or circulatory disease, is characterized by its limitation

[1] Read at the Twenty-first Annual Meeting of the Radiological Society of North America, in Detroit, Dec. 2–6, 1935.

to the affected part. The following two types may be observed: (1) a homogeneous decalcification of bone, with thinning of the trabeculæ, which, however, remain sharply defined, despite their thinness, and (2) a coarse, mottled form of osteoporosis, which has been confounded with multiple myeloma and metastatic malignancy. This type has been called subacute atrophy of bone, but this is a misnomer, since the condition may occur in such chronic states as thrombo-angiitis obliterans (Buerger's disease), arteriosclerosis, and in injuries of the peripheral nerves.

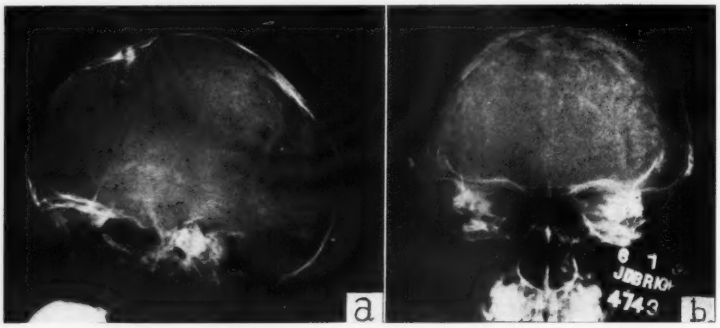

Fig. 1. Osteogenesis imperfecta; *a*, lateral view of skull revealing osteoporosis, numerous wormian bones in lambdoidal suture, and protuberant occipital bone; *b*, postero-anterior view, revealing osteoporosis, numerous wormian bones in lambdoidal suture, and protuberant temporal bones.

CONGENITAL DEFECTS

In this group are placed those cases in which the bones are fragile, not because of any primary defect in calcium metabolism, but because of a failure on the part of certain primitive cells to differentiate into their normal tissues. The basic defect appears from histologic examination to be an inability to form osteoblasts. These are commonly described as few in number and anomalous in structure. In this class are placed osteogenesis imperfecta and fragilitas ossium, probably the same pathologic processes, except that the former concerns the fetal or infantile form and the latter concerns the adult form. Both have a tendency to be hereditary and familial. The degree of liability to fracture varies in different cases, and usually tends to become less after puberty. The entire skeleton is affected, and roentgenologic changes in the infantile form are characteristic. The bones have a bowed, misshapen, shortened, and thickened appearance. Callus is easily detected in the shafts at the sites of fracture. Compression of the thorax and fracture of the ribs are common. Ossification in the skull is deficient and irregular and, according to Knaggs (2), has a peculiar mosaic appearance because of the irregular islands of wormian bones, which occur particularly along suture lines. A bitemporal and occipital protuberance of the skull is common (Figs. 1-*a* and 1-*b*). In the adult variety, there is generalized osteoporosis and marked atrophy of the cortex and shafts of the long bones, bowing, infractions, and fractures occur in varying degrees.

No abnormality in the values for the serum calcium, plasma phosphorus, or excreted calcium has been satisfactorily demonstrated. The plasma phosphatase tends to be increased, but this is not constant. In two cases which were recorded by Bauer (3), the parathyroid glands were enlarged, and histologically exhibited hyperplasia.

DIETARY INSUFFICIENCY AND AVITAMINOSIS

Rickets and osteomalacia constitute the

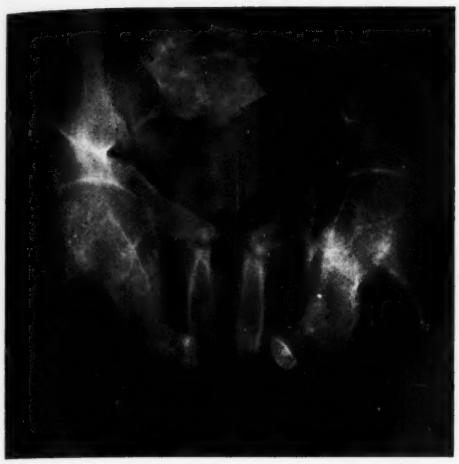

Fig. 2. Osteomalacia, resulting from non-tropical sprue. Deformity of pelvic bones was the result of weight-bearing. Pubic bones show osteoid zones which simulate fractures.

Fig. 3. Osteomalacia, resulting from dietary insufficiency and deprivation of sunlight. Arrows indicate osteoid zones which simulate fractures.

lesions of this group, which result from a deficient supply of calcium or phosphorus in the food, or a deficient intake of vitamin D. There is little doubt that they are one and the same disease, except that rickets affects the growing child and osteomalacia affects the adult. The roentgenologic changes of rickets are so well known that they will not be reviewed here. In the past, the term "osteomalacia" has, by tradition, been applied to the particular softening of bones which occurs among pregnant and lactating women. Experience has shown, however, that such changes are not limited to pregnancy and lactation, but may occur whenever the diet is deficient in calcium, phosphorus, or vitamin D. Notable examples of this include hunger osteomalacia and the osseous changes which occur in celiac disease and in chronic idiopathic steatorrhea (non-tropical sprue) (Fig. 2). The significant roentgenologic changes consist of generalized osteoporosis, marked thinning of the cortical bone, with softening, bowing, fractures, kyphosis, and generalized deformities. Of particular interest are the transverse osteoid zones, described by Looser (4), which simulate pathologic fractures. They usually occur in cases in which the disease is well advanced, and they have a tendency to be symmetrically distributed (Fig. 3). Osteomalacia, especially the senile variety, is frequently confounded roentgenologically with the skeletal changes of hyperparathyroidism, particularly when the latter condition has not advanced sufficiently to exhibit the granular osteoporosis that is so typical of later phases of the disease. Formation of cysts, which is common in hyperparathyroidism, does not occur in osteomalacia, and the transverse osteoid zones (*"Umbauzonen"* of Looser) which are so common in osteomalacia, are not observed in hyperparathyroidism. In doubtful cases blood chemistry and even biopsy of a bone may be necessary to distinguish osteomalacia from hyperparathyroidism.

RENAL INSUFFICIENCY

Renal dwarfism is a condition occurring in children, in association with, and apparently as a result of, chronic renal insufficiency. The stunting of growth and delayed union of epiphyses may be complicated by a rachitic process, which has all the clinical, roentgenologic, and histologic characteristics of true rickets. Notwithstanding, renal rickets is not caused

by a lack of vitamin D, but by a disturbance of the metabolism of endogenous calcium and phosphorus, which evidently

Fig. 4. Renal rickets; bones of forearm reveal typical rachitic changes.

is the result of the chronic nephritis. Roentgenologically the findings vary a great deal in different cases, and sometimes in the same case at various times. Skeletal development is always retarded. In some instances there is a zone of osteoid tissue at the growing ends of bones, which may not be different from that seen in ordinary rickets (Fig. 4). However, there usually is something atypical about the findings, and the lesions may be asymmetrical, or different bones may be involved unequally. In cases in which the condition has been present for a long time, there is a deep mottled zone at the ends of the long bones, which consists of osteoid tissue, cartilage, fibrous tissue, and calcified matrix. Distortion, infractions, and various deformities may result. Defects in subperiosteal calcification and a coarse, thickened appearance of the skull have been noted by Parsons (5) and Teall (6) in cases in which the disease is advanced.

The granular appearance of the skull in cases in which the disease is advanced more closely simulates the granular osteoporosis of hyperparathyroidism than does any other malacic disease of bone that I have observed (Fig. 5). The question of the relation of hyperparathyroidism to renal rickets has been raised by Shelling and Remsen (7), who reported a case of renal rickets in which marked hyperplasia of the parathyroid glands was observed. In renal rickets, however, the nephritis antedates the skeletal changes, whereas, in hyperparathyroidism, the skeletal changes usually antedate the nephritis.

ENDOCRINE DYSFUNCTION

Hyperparathyroidism. — Hyperparathyroidism has been well established as a clinical entity, and it is now recognized that the condition may be caused by a hyperfunctioning adenoma of one parathyroid gland (rarely two), or by generalized primary hyperplasia of all the parathyroid glands. In considering hyperplasia, it must be emphasized that this also can occur without evidence of hyperparathyroidism. This type is designated as secondary, functional, or compensatory hyperplasia, and may occur in association with generalized lesions, such as rickets, osteomalacia, multiple myeloma, and metastatic carcinoma, which involve the skeletal system. In such conditions, the hyperplasia occurs because of the demand for parathyroid hormone to maintain the normal amount of the serum calcium. In hyperparathyroidism which results from generalized hyperplasia of all parathyroid glands, there apparently exists some factor which promotes all parathyroid tissue to produce more hormone than is needed.

Roentgenologically, the fundamental skeletal change in hyperparathyroidism is revealed as a demineralization of the entire skeletal system. In the early stages of the disease, the trabeculæ of the bones

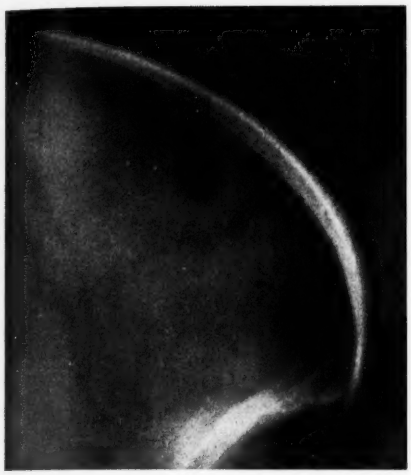

Fig. 5. Renal rickets; section of roentgenogram of skull reveals fine, granular osteoporosis that simulates the appearance of hyperparathyroidism.

Fig. 6. Hyperparathyroidism; section of roentgenogram of skull reveals the miliary granular osteoporosis, characteristic of this disease.

are thinned out and become delicate in structure. As resorption of calcium progresses, the trabeculæ become indistinct in outline, and the cortical bone becomes so thin that the bones have a homogeneous ground-glass appearance. This has been referred to as the osteoporotic form of hyperparathyroidism, and is indistinguishable from the osteoporosis of osteomalacia, hyperthyroidism, and particularly senile osteoporosis. In such cases, complete metabolic studies and even biopsy may be necessary to establish the presence of hyperparathyroidism. As the disease progresses into the more classic form (von Recklinghausen's disease or generalized osteitis fibrosa cystica), the osteoporosis develops a characteristic, uniform miliary granular appearance that is distinct from the ordinary type of osteoporosis, associated with acute and chronic disease of bone and with neurotrophic conditions. It is best exhibited in the flat bones, especially the calvarium (Fig. 6), where it may be closely simulated by the osseous changes which accompany the blood dyscrasias of childhood (Fig. 10), renal rickets (Fig. 5), and occasionally multiple myeloma. In many regions the decalcification progresses and produces multiple cystic lesions (osteitis fibrosa cystica generalisata) of varying size, which may be found within the medullary portion or below the periosteum. The jaws, pelvis, long bones, ribs, and metatarsal and metacarpal bones are favorite sites for such changes. The subperiosteal zones of resorption are especially well shown at the ends of long bones and in the phalanges. Cysts may reach a large size, and locally may simulate a giant-cell tumor, although the expansion of the cortex which is so common in the latter is generally less marked in hyperparathyroidism. Pathologic fractures through the cystic regions are common. Because the bones are soft, bowing, fractures, kyphosis, narrowing of the pelvis, coxa vara, and deformities of the ribs are common.

Following the removal of the cause of the hyperparathyroidism (tumor or primary hyperplasia), a very obvious change occurs in the structure of the skeletal system. As the resorption of calcium is arrested, the trabeculæ of bones lose their indistinct outline and become well defined. As convalescence occurs, the density of the bone gradually approaches the normal, although such deformities as bowing, kyphosis, and scoliosis will persist. Cystic

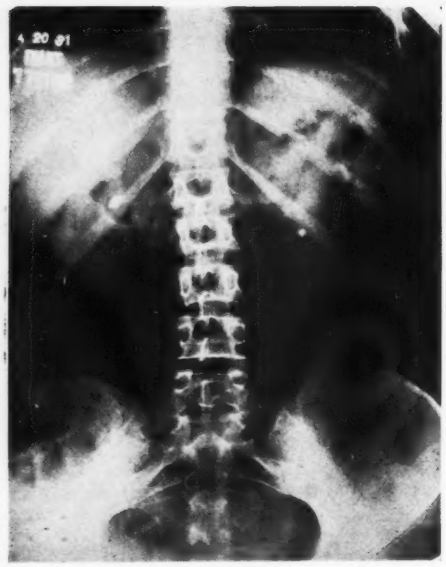

Fig. 7. Hyperparathyroidism; roentgenogram of upper part of urinary tract reveals urinary calculi. The osteoporosis of the ribs, vertebræ and pelvis is very slight and might easily be overlooked.

regions gradually fill in with bone and may disappear completely.

In addition to the changes in the skeletal system, the hypercalcinuria and hyperphosphaturia of hyperparathyroidism are frequently responsible for the formation of renal calculi. The formation of such calculi will depend on the amount of calcium and phosphorus excreted in the urine, the intake of fluid, the alkalinity of the urine, and the degree of polyuria. Hence, the chief symptom in a case of severe hyperparathyroidism of short duration may be renal colic. In such cases, the roentgenologic appearance of the bones may be normal, or the osteoporosis may be so slight that it is easily overlooked (Fig. 7). Experience has shown that if hyperparathyroidism is suspected in all cases of urinary calculi, the disease frequently can be diagnosed before significant skeletal changes have occurred.

Hyperthyroidism.—The presence of osteoporosis in exophthalmic goiter was demonstrated radiographically by Kummer (8), in 1917. Since that time, several observers have confirmed his observations. The demineralization is generalized, but is more marked in the spongy than it is in the compact portions of bone. In one of a series of cases reported by Dunlap and Plummer (9), in 1928, necropsy revealed generalized osteoporosis, especially of the calvarium and ribs; the latter exhibited multiple fractures. According to Hunter (10), there seems to be no relation between the duration of the disease, the degree of osteoporosis, and the value for phosphatase in the plasma, which often is high.

Cushing's Syndrome (Basophil Adenoma of the Pituitary Gland).—Generalized osteoporosis is one of the features of a syndrome associated with basophil tumors of the anterior lobe of the pituitary gland. Whether or not secondary hyperparathyroidism is present, as a result of hyperplasia of the parathyroid glands, has not been definitely established. The osteoporosis is of the homogeneous type, and simulates osteomalacia, particularly the senile variety, and the osteoporotic form of hyperparathyroidism. In my experience, the bony changes have been identical with those observed in the syndrome resulting from suprarenocortical tumors. Because of the heavy torso, compression deformities of the decalcified vertebral bodies are common. One patient (Fig. 8) revealed multiple pseudofractures of the ribs, as a result of Looser's "*Umbauzonen.*" This is most interesting because these osteoid bands which simulate fractures, commonly are observed in osteomalacia and rickets, in which the underlying cause is, of course, a dietary or vitamin deficiency. As far as I am aware, they have not been observed in hyperparathyroidism. In the same patient there was definite enlargement of the sella turcica, characteristic of a pituitary tumor, but this has not been a constant finding in the cases described in the literature.

Suprarenal Disease.—The literature contains much conflicting data regarding the relation of the suprarenal glands to calcium metabolism and to osteomalacia. Golden

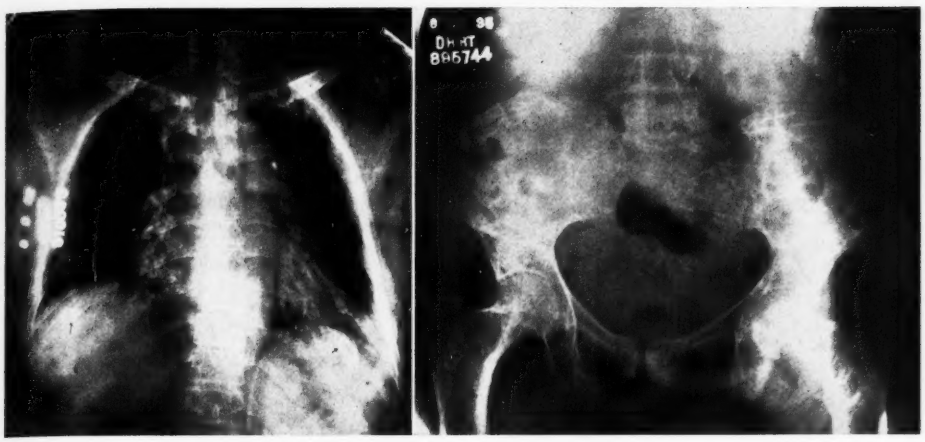

Fig. 8. Osteomalacia, resulting from Cushing's syndrome (basophilism). The osteoporosis is homogeneous in character. Arrows indicate osteoid zones, which simulate fractures in the ribs; their symmetrical distribution may be noted.

Fig. 9. Hyperparathyroidism—fibrocystic changes in pelvic bones simulating osteitis deformans (Paget's disease).

and Abbott (11), who reviewed the literature, concluded that, although the secretion of the suprarenal glands either directly or indirectly influences calcium metabolism, and although the suprarenal glands may be indirectly involved in a pluriglandular imbalance in certain cases of osteomalacia, the evidence did not seem to justify the assumption that decalcification of bones results directly from suprarenal disease or dysfunction. Nevertheless, osteoporosis of the homogeneous type occurs in a syndrome resulting from hyperplasia or a tumor of the suprarenal cortex, and surgical removal of such a tumor in several instances has been followed by complete repression of the abnormalities which characterize the syndrome. As stated before, the osseous changes which accompany this syndrome are identical with those which occur in pituitary basophilism. It is significant that the "*Umbauzonen*" of Looser (pseudofractures), which are so common in osteomalacia and rickets, also occur in this condition. Clinically, the syndrome has not been conclusively separated from Cushing's syndrome (basophilism), and the roentgenologic differentiation is impossible.

Pancreatic Disease (*Diabetes Mellitus*).—There is considerable evidence in the literature to show that a loss of calcium occurs in diabetes, especially in the presence of acidosis. Morrison and Bogan (12) found that atrophy of bone occurs among a certain number of children in whom diabetes develops before the ninth year, but not in children in whom diabetes develops after that. Narrowing of the shafts and thinning of the cortex were noted in the bones of children with long-standing diabetes. Decalcification was observed in diabetes among adults by Golden and Abbott (11), but according to them the question may be raised as to how much of this is of endocrine and how much of nutritional origin.

(*Carcinoma of the Pancreas and Pancreatitis*).—The osteoporosis occasionally observed in these conditions is identical with that observed in osteomalacia. It seems logical to conclude that it results from deficient absorption of calcium in the presence of a defective digestion of fat and an associated diarrhea rather than from any direct effect of internal pancreatic secretion. This is further substantiated by the fact that the bony changes are identical with those observed in cases of idiopathic steatorrhea (nontropical sprue).

MISCELLANEOUS CONDITIONS OF UNKNOWN ETIOLOGY

Focal Osteitis Fibrosa Cystica.—Localized or focal osteitis fibrosa cystica has been termed "osteodystrophia cystica juvenilis" by von Mikulicz (13). This condition is frequently confounded with hyperparathyroidism because, roentgenologically and pathologically, the localized cysts simulate the cystic lesions of hyperparathyroidism. The condition is not related to hyperparathyroidism, and can be distinguished from it by the presence of normal bone in the uninvolved regions, by the presence of normal amounts of calcium and phosphorus in the serum, and by the presence of normal amounts of phosphatase in the plasma.

Osteitis Deformans (Paget's Disease).—The roentgenologic characteristics of this disease, which may affect one or several bones, are so well known that they need not be repeated here. Of more importance is the question whether or not this disease is a manifestation of hyperparathyroidism, as has been claimed by some observers. By analogy with generalized osteitis fibrosa cystica, it would seem likely that osteitis deformans is a disorder of mineral metabolism and, according to Hunter and Turnbull (14), there is only one definite histologic difference between the two diseases; this, however, is a big difference. In osteitis deformans, there is tremendous resorption of bone; this is associated with tremendous apposition which completely alters the normal architecture, although apposition predominates. In generalized osteitis fibrosa cystica, widespread resorption of bone is the essential change and excessive apposition is focal and relatively insignificant. Enlargement of the parathyroid glands has not been demonstrated in osteitis deformans, and the values for the calcium and phosphorus of the serum are normal, in contrast to the values for these inorganic constituents in hyperparathyroidism.

Roentgenograms usually will serve to distinguish the two diseases. The fundamental distinction is that in osteitis deformans the lesions are confined to one or several bones, the uninvolved bones being normal, while in hyperparathyroidism the entire skeletal system is affected. The coarse striated appearance of the involved bones in osteitis deformans, the enlargement of the cortical portions, the characteristic coarse mottling, and the enlargement of the calvarium readily identify this condition. The fine granular osteoporosis of the calvarium in hyperparathyroidism is very different from the coarse mottling of osteitis deformans, even though thickening of the skull may occur in either disease. A local lesion in an occasional case of hyperparathyroidism may closely simulate the appearance of osteitis deformans (Fig. 9), but, even so, the two conditions should not be confounded if the general differences which have been noted are borne in mind.

In addition to the conditions that have already been discussed, there are certain other diseases which, because of their involvement of the osseous system, may be confounded roentgenologically with true malacic diseases of bone. These include metastatic carcinoma, multiple myeloma, diseases of the reticulo-endothelial system, and certain blood dyscrasias, particularly those of infancy and childhood.

The extensive involvement of the skeletal system in advanced metastatic carcinoma and multiple myeloma may at first glance simulate the roentgenographic appearance of hyperparathyroidism. However, the multiple regions of destruction of bone in these conditions, in the calvarium especially, are easily distinguished from the miliary, granular osteoporosis of the skull in hyperparathyroid disease. True formation of cysts is absent in each of these conditions, whereas, it is common in hyperparathyroidism. In hyperparathyroidism, the entire skeleton is affected, whereas, in multiple myeloma and in metastatic carcinoma, regions of uninvolved normal bone generally can be found, regardless of the extent of the disease. Because of marked skeletal destruction, values for the serum calcium and plasma phosphatase may be

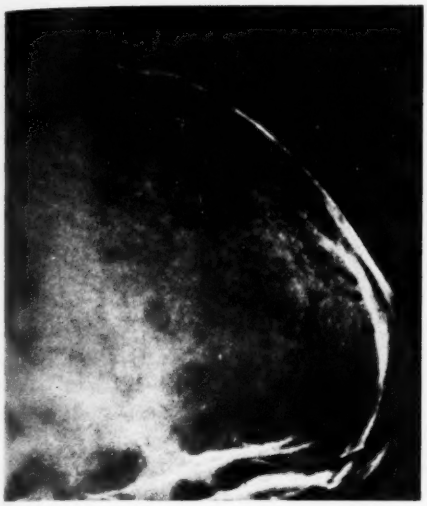

Fig. 10. Lymphatic leukemia; section of roentgenogram of child's skull reveals granular osteoporosis, which closely simulates that observed in hyperparathyroidism.

Fig. 11. Lymphatic leukemia; roentgenogram of femurs and portion of pelvic bones reveals diffuse osteoporosis; the periosteal thickening, which is frequent in this condition, is well shown in each femur.

high. However, the value for the serum phosphorus, if changed, is higher than normal, in contrast with the low value for serum phosphorus in hyperparathyroidism, except in the presence of severe renal damage, when the value for the serum phosphorus may be increased. The fact that hyperplasia of the parathyroid glands may occur in myeloma has been cited as evidence that the latter disease is of parathyroid origin. However, hyperplasia of the parathyroid glands also has been observed in metastatic carcinoma of bone, in rickets, and in osteomalacia, and the majority of observers agree that it is undoubtedly a secondary rather than a primary factor in these conditions. Also, reliable records exist of cases of multiple myeloma wherein the calcium and phosphorus metabolism was normal, and normal parathyroid glands were found at necropsy.

Disease of the Reticulo-endothelial System.—Xanthomatosis should not be confused with hyperparathyroidism. It occurs most frequently during early childhood, but occasional adolescent and adult types have been noted. The resorption of bone is really a destructive, pressure atrophy which is caused by the contiguous accumulation of granuloma-like lipoid masses in the connective tissue. The flat bones are more commonly involved than are other bones, but any part of the skeleton may be affected. The plaque-like zones of destruction in the skull are very different from the granular osteoporosis of hyperparathyroidism. The unaffected bones and uninvolved regions of the same bone also exhibit a normal structure, in contrast to the diffuse involvement in hyperparathyroidism.

Gaucher's Disease.—This condition provokes changes in the skeletal system that are more similar to osteomalacia than they are to hyperparathyroidism. The crowding of bone marrow with so-called Gaucher cells results in atrophy of the spongy portions of the bones and widening of the intramedullary space. While the changes must be generalized, they are particularly obvious in the ends of the femur and humerus. According to Schinz and others (15), changes in the skull are observed

only in cases in which the condition is advanced. Because of the hematologic findings and the presence of splenomegaly, this condition would not be confused clinically with osteomalacia.

Blood Dyscrasias.—The roentgenologic manifestations of these conditions have been described in detail by Karshner (16), and by Vogt and Diamond (17). The latter investigators classified the whole group under the general heading, "congenital anemias." Fundamentally, the changes in the osseous system are the result of a generalized hyperplastic condition of the marrow, which causes decalcification of the trabeculæ and thinning of cortical bone. The changes are well shown in the calvarium, where a generalized mottling or spongy appearance similar to hyperparathyroidism may be observed (Fig 10).

In the erythroblastic form, the medullary portion of the calvarium may be thickened, and the outer and inner tables may be correspondingly thinner. In the later stage of this disease, formation of new bone occurs, which is revealed as striations perpendicular to the tables. According to Karshner (16), these striations in the skull suggest replacement of exhausted marrow by bone.

Among patients with leukemia, especially of the lymphatic variety, periosteal elevation and thickening, which are the result of subperiosteal leukemic infiltration, commonly occur. In addition, small or extensive foci of destruction of bone, which cause a moth-eaten appearance of the medulla, may be noted (Fig. 11).

Clinically, the diagnosis of the various congenital anemias is not difficult, although, roentgenologically, they may be confounded at certain stages with hyperparathyroidism and with osteogenesis imperfecta.

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RADIOTHERAPY FOR BONE TUMORS[1]

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ALTHOUGH the classification of bone tumors is still difficult and unsatisfactory, a definite improvement in this respect has occurred during the past few years. Moreover, it is gratifying to know that radiology has played a valuable part in this improvement. The roentgenographic features of such abnormal growths are often distinctive, but sometimes they are not and an absolute diagnosis cannot be made. When tissue from such a tumor can be removed for microscopic examination, the growth can usually be identified. In certain cases, unfortunately, different pathologists cannot agree on the essential character of the tumor. As the experience of radiologists has increased, their attention has been attracted by the fact that certain tumors of bone are sensitive to radium or roentgen rays, while others are much less sensitive. By radiotherapeutic tests alone, or by correlating such tests with the pathologic data, it is now possible to distinguish certain tumors from others with which they had previously been confounded. Thus, one of the features which influenced Ewing in recognizing diffuse endothelioma of bone from osteogenic sarcoma was the peculiar radiosensitiveness of the former in contrast to the relative resistance of the latter. To one who has had sufficient experience this feature is so striking and, on the whole, so uniform that it constitutes a most valuable point by which these two varieties of tumor can be distinguished. As time goes on, the relative radiosensitiveness of different varieties of tumor bids fair to assume an increasingly important rôle in the diagnosis and, perhaps, in the classification of tumors arising in the human skeleton.

Physicians who are not well versed in radiology often mistake radiosensitiveness and radioresistance as absolute expressions. To them a tumor is either sensitive or resistant to irradiation, and intermediate gradations are not recognized because of lack of experience with this phase of medicine. Experienced radiologists, on the contrary, use these terms only in a relative sense because they know that, just as different varieties of normal cells vary greatly in sensitiveness to roentgen rays or radium, tumors vary equally in this respect. Moreover, it has been established that the radiosensitiveness of any tumor corresponds to that of the cells of which it is chiefly composed. In the case of a mixed tumor, its sensitiveness to irradiation represents a composite of its cellular elements; when sensitive cells predominate, the degree of sensitiveness is greater than when the proportion of sensitive cells is small. It is clear that the scale of radiosensitiveness of different varieties of neoplasms must, and in fact does, correspond to the degree of sensitiveness of its essential cellular constituents. Therefore, to speak or write of a tumor as being sensitive or resistant to irradiation, without qualification to indicate the grade or relative degree of these qualities, is to mislead internists, surgeons, pathologists, and others into assuming that a tumor is either 100 per cent sensitive or 100 per cent resistant. The simile of red and white in the scale of colors is too obvious to require mention.

BENIGN TUMORS

Among the benign tumors of bone, the most common are osteochondroma and the so-called giant-cell tumor.

Osteochondroma.—Benign from the outset, this variety of growth often remains so. However, such tumors are prone to undergo malignant transformation. As long as their benign character is preserved they are not perceptibly influenced by exposure to radium or to roentgen rays. But when

[1] Read before the Radiological Society of North America, at the Twenty-first Annual Meeting, in Detroit, Dec. 2–6, 1935.

malignant transformation occurs, the tumor assumes the character of chondrosarcoma, and its radiosensitiveness corresponds to that of the latter variety (*q.v.*).

Giant-cell Tumor.—In most cases the growth has the character of a chronic inflammatory process, of the nature of a granuloma, and is, therefore, essentially benign. However, it is well known that, under certain ill-defined conditions, a small proportion of such growths may become malignant. Extended experience has shown that when the growth has not destroyed or weakened the affected bone too much, and when repeated hemorrhage within the tumor has not caused more or less marked secondary anemia, thorough irradiation may often cause it to retrogress completely and permanently. The rate of retrogression is moderate and, when this is complete, the area corresponding to the growth is slowly replaced by newly formed bone. Such replacement may require from six months to two years.

A certain proportion of these tumors exhibit a reaction which is peculiar to them and which is not observed in any other variety of tumor, benign or malignant. Two or three weeks after irradiation, the tumor, which in the meantime has not shown any perceptible change, and the part in which it is situated begins to swell, and the swelling is accompanied by redness, pain, and tenderness. To the patient as well as to the uninitiated physician these manifestations give the impression that irradiation has increased the activity of the tumor, and the resulting panic may lead to a hasty and unnecessary amputation. If not disturbed, the swelling, redness, and pain begin to subside after a week or ten days and gradually disappear. New bone is then slowly deposited in the tumor which, in the course of time, is replaced by solid bone.

In some cases, for a variety of reasons, surgical treatment may be preferable to radiotherapy. The reasons may be economic, in that it may be important for the patient to shorten the period of disability as much as possible, irrespective of other factors; or, repeated hemorrhage in or around the tumor may previously have occurred, and a considerable degree of anemia may have developed. In such cases it is sometimes necessary or advisable to operate on, or even to amputate, the limb in order to save life.

MALIGNANT TUMORS

Among the malignant neoplasms that affect bone the most common are: hemangioma; hemangio-endothelioma; diffuse endothelioma (Ewing) or endothelial myeloma (Kolodny); chondrosarcoma; osteogenic sarcoma; myxoma, or neoplasms in which various combinations of fibrous, cartilaginous, myxomatous, and osseous tissues occur; metastatic carcinoma from the breast, thyroid gland, or some other organ, and multiple myeloma.

Hemangioma.—When hemangioma affects a bone it reacts to roentgen rays or to radium as does hemangioma affecting any other structure. In other words, hemangioma is moderately radiosensitive. Repeated exposure of such a lesion to a moderate dose of rays is often, if not usually, followed by gradual regression and improvement, until complete healing occurs. If more growths of this variety are not cured, it is perhaps because they are not recognized, because the treatment is not repeated or continued long enough, or because excessive doses are employed. An interesting feature of hemangioma from a radiotherapeutic point of view is that a moderate quantitative dose of rays seems to be more effective than doses that strain or approximate the tolerance of the skin. By a moderate dose is meant one representing 75 per cent or 80 per cent of the erythema dose. This should be repeated every three or four weeks for several months or as long as the patient's condition continues to improve. Maximal tumor doses, such as are essential for chondrosarcoma or osteogenic sarcoma, are not so effective. Another feature is the relative slowness with which tumors of this kind recede and finally disappear after systematic and repeated irradiation.

Hemangio-endothelioma.—When hemangiomatous and endotheliomatous elements are combined in a tumor, its degree of malignancy and its tendency to metastasis are greater, and its radiosensitiveness is less than those of either of its component cellular elements. This probably explains why radiotherapy for such neoplasms is distinctly less effective than it is for either hemangioma or endothelioma. Moderate, temporary regression and improvement may not infrequently be observed, but few such neoplasms undergo substantial or prolonged regression after irradiation, irrespective of the technical conditions or of the scheme of treatment.

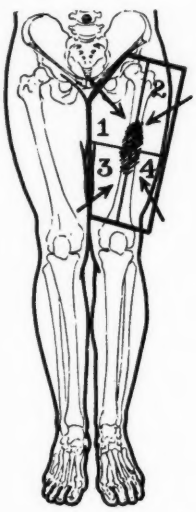

Fig. 1.

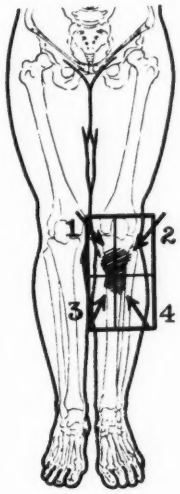

Fig. 2.

Fig. 1. Tumor of the middle third of the femur. Scheme of irradiation through six fields.

Fig. 2. Tumor of the upper third of the tibia. Scheme of irradiation through four fields.

Endothelioma (Endothelial Myeloma).—Of all the malignant tumors of bone, endothelioma is by far the most sensitive to radium or to roentgen rays. Moreover, the radiosensitiveness of different growths of this character seems to be more uniform than that of most other neoplams. Such is the relative uniformity of radiosensitiveness of endothelioma that a positive diagnosis can usually be made by observing the rate of regression after irradiation, irrespective of the pathologic findings. Thorough exposure to roentgen rays is usually followed by rapid regression, and repeated irradiation may occasionally result in permanent cure. What prevents a cure in a large percentage of cases is metastasis which, though not apparent when radiotherapy is instituted, manifests itself during the ensuing weeks or months.

The successful treatment of endothelioma requires that a large total dose should be concentrated on it. This can often be done without exposing any field to a dose that might tax the endurance of the overlying tissues. To accomplish this it is usually best to divide the region occupied by the growth into as many fields as possible, the common center of all the fields corresponding as closely as possible to the center of the neoplasm. Then each field may be exposed to a moderate erythema dose of roentgen rays (from 500 to 550 roentgens, measured in air), on successive days, or all the fields may be exposed to a small dose each day for from 15 to 30 days. Regardless of the scheme of irradiation with reference to the time consumed, an

important consideration is that, in treating the different fields, the several beams of rays should be made to converge accurately on the tumor. Too much attention cannot be given to this point. Another consideration which may not be neglected with impunity is that, when the number of fields irradiated is large, the quantitative dose per field must be correspondingly reduced. Failure in this respect may mean a grossly excessive total dose in some part of the growth or of the normal tissues in the irradiated territory. If excess in dosage could be restricted to the growth itself, it could be regarded with equanimity, and even with satisfaction. But since such restriction is impossible, and since excessive irradiation may injure the normal tissues adjacent to the tumor or the bone in which the neoplasm is growing, an excessive total dose should be carefully avoided. Of course, moderate injury to adjacent structures may sometimes be disregarded in order to make more certain of arresting the malignant process. When this is done, however, the circumstances and the possibility of deleterious after-effects should be frankly explained beforehand to the patient, to a responsible relative, or to the attending physician. The radiologist should always bear in mind that, in dealing with a variety of tumor which is so radiosensitive as endothelioma, complete regression of the primary growth, and sometimes of secondary deposits as well, can usually be induced with relatively moderate doses and without risk of interfering with normal repair of the affected bone.

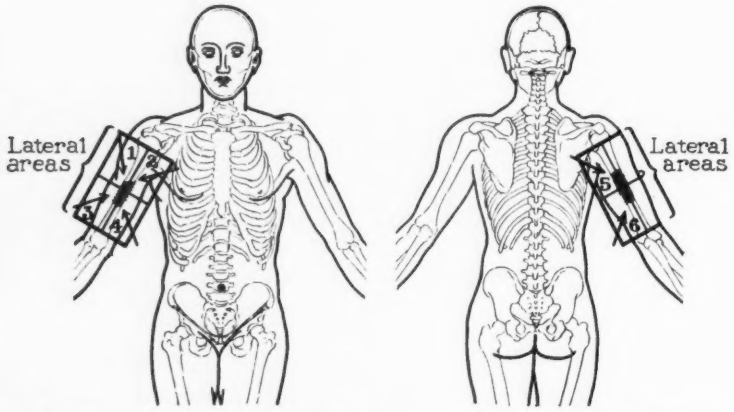

Fig. 3. Tumor of the middle third of the humerus. Scheme of irradiation through six fields.

As far as repetition of treatment is concerned, this must depend on the circumstances peculiar to each case. When the initial course of treatment is given within a week or ten days, the treatment should usually be repeated once, twice, or even three times, at intervals of from three to six or eight weeks, depending on the quality of rays employed, on the number of fields irradiated, on the behavior of the neoplastic process, and on the condition of the patient. When the treatment is given in small, daily increments, when this is continued for from 20 to 40 days, and when the total dose of rays directed toward the tumor is large, the treatment either should not be repeated at all or only once after an interval of from two to six months.

Chondrosarcoma.—The radiosensitiveness of bone tumors derived from cartilage is intermediate between that of endothelioma on the one hand and that of osteogenic sarcoma on the other. The difference in sensitiveness between chondrosarcoma and endothelioma is distinctly greater than that between chondrosarcoma and osteogenic sarcoma. This is but another way of saying that, on the whole, tumors de-

rived from cartilage are comparatively resistant to irradiation. Moderate, and sometimes fairly marked, regression may

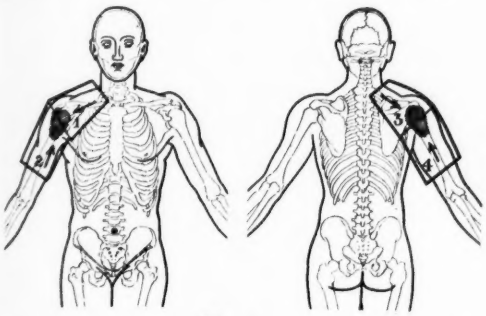

Fig. 4.

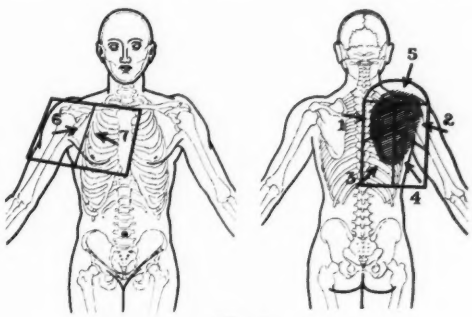

Fig. 5.

Fig. 4. Tumor of the upper third of the humerus. Scheme of irradiation through four fields.
Fig. 5. Tumor of the scapula. Scheme of irradiation through seven fields, four of which are posterior, one suprascapular and supraclavicular, and two anterior.

be induced by thorough irradiation; this may continue for weeks or months and may be accompanied by partial or complete relief from pain, but sooner or later, in the majority of cases, the tumor again becomes active, metastasis occurs, and death ensues.

Discouraging as the outlook may seem, and usually is, the degree of improvement obtained by thorough treatment may amply repay the radiologist for his efforts. In some cases at least, the duration of improvement may be sufficient to justify this therapeutic procedure, unless the disease is advanced or extensive metastasis already has occurred. When the patient's general condition is good and when metastasis cannot be demonstrated, a thorough trial of radiotherapy is warranted. If such a trial is not accompanied or followed by relief from pain and substantial regression of the neoplasm, the patient should not be urged to submit to further treatment.

Osteogenic Sarcoma.—As a group, tumors of this variety are more resistant to irradiation than any malignant tumors of bone, with the exception of chondromyxosarcomas or fibromyxosarcomas. Some degree of regression may follow intensive irradiation, pain may be relieved for a time, and a measure of improvement in the condition of the patient may occur. Usually, however, the degree and duration of improvement are even less than in chondrosarcoma. A few cases of osteogenic sarcoma, apparently cured by radiotherapy, have been reported, but their authenticity may perhaps be questioned.

Myxosarcoma.—Even more resistant to irradiation than osteogenic sarcoma are tumors of bone of which myxomatous tissue, alone or combined with fibrous or cartilaginous tissue, constitutes a more or less important element. Seldom can perceptible regression of such a neoplasm be observed, regardless of the dose of roentgen rays or radium to which it may be exposed. Naturally, this refers to doses within the therapeutic range, which is to say doses that are not sufficient to cause permanent injury to adjacent normal bone. If this restriction were not considered, a dose large enough to induce massive necrosis of the growth might readily be given; but since the necrosis would undoubtedly affect the normal as well as the abnormal tissues in the irradiated territory, the advisability of such a ruthless procedure seems rather doubtful. At least, no one has had the temerity to advocate it, or even to try it.

Metastasis to Bone from Tumors Originating in Soft Tissues or Organs.—Metastasis to bone from carcinoma of the breast can often be favorably influenced by irradiation. Sometimes marked regression of the secondary malignant elements may occur and, in an occasional case, the metastatic lesions may heal completely and remain

healed. Unfortunately, other lesions of the same kind are prone to develop in the same or in some other region, and death is a foregone conclusion. In some cases, however, it is astonishing how long a patient may harbor extensive metastasis to bone, sometimes without any perceptible influence on his general condition for many months and, occasionally, for several years.

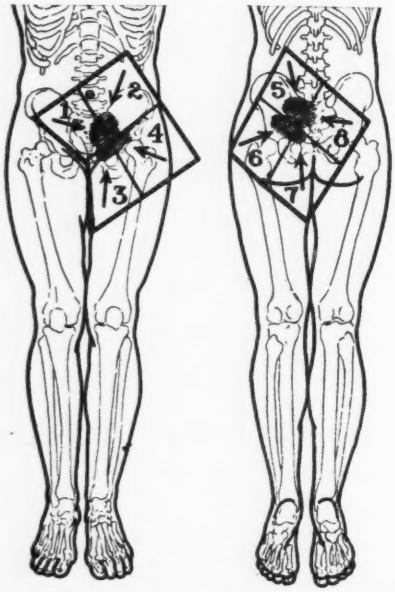

Fig. 6. Tumor of the ascending ramus of the pubic bone, projecting into the pelvis. Scheme of irradiation through eight fields, four anterior and four posterior.

Pain confined to the back, or pain in the back radiating to one or both hips and lower extremities, is a common complaint of patients suffering from carcinoma of the breast, whether or not the affected breast has been previously amputated. The pain is undoubtedly caused by metastatic invasion of the spine, and probably results from irritation or pressure on spinal nerve roots by metastatic lesions in the vicinity of the foramina. In many cases, however, the pressure of metastatic changes in the spinal bones cannot be demonstrated for some time after the onset of pain. Why this manifestation should develop in the lumbar and lower thoracic regions so much more frequently than elsewhere remains an unsolved problem, but the fact is undeniable. Thorough irradiation of the lumbar and lower thoracic regions, and sometimes of the sacroiliac regions also, through bilateral fields, with the rays converging sharply on the spine, can usually be counted on to relieve pain for weeks or months. The same may be said of metastasis to bone from carcinoma of the prostate gland or uterus, except that, in such cases, relief from pain by radiotherapy cannot be depended on, and the duration of relief is not so great as in the case of carcinoma of the breast.

Metastasis to bone from carcinoma of the thyroid gland often exhibits a considerable degree of radiosensitiveness in comparison with metastasis from carcinoma of the breast, prostate gland, or uterus. This is not so true when the primary tumor is an adenocarcinoma. But when the primary growth is an ordinary carcinoma, it is often astonishing how readily the metastatic deposits retrogress and how much regeneration of bone may occur after thorough and repeated irradiation. When metastasis is confined to a single focus, a cure may still be possible. Almost always, however, metastasis is multiple and, while its progress may be arrested for varying periods, its unfavorable evolution sooner or later is resumed.

Multiple Myeloma.—If discovered early, when the malignant process is limited to the skull or to some other restricted portion of the skeleton, radiotherapy may check its progress or the lesions may diminish in number and activity, and the condition of the patient may improve considerably for months and sometimes for two or three years. Unfortunately, the onset of the disease usually is so insidious that, in the majority of cases, when the patient realizes that his health is deteriorating, the pathologic disturbance already has spread to many bones. When the malignancy has thus extended to widely scattered portions of the skeleton, radiotherapy is seldom followed by marked or prolonged improvement. In some cases, pain may be partly or completely relieved, and moderate improvement for weeks or months may occur.

Rarely, such improvement may continue for more than a year; then the disease again becomes active and advances on its fatal course, and the patient dies.

When pain is a prominent feature, the painful region should be irradiated first. Then other adjacent or remote regions, in which the malignant process may also be present, may be irradiated. When pain is not the outstanding complaint, the region of principal involvement should be treated first, and this should be followed by irradiation of other regions in which the evidence of disease is not so pronounced. Protracted, fractional irradiation cannot be employed effectively because of the extent of the condition and because the disturbance tends to spread to so many bones. It is preferable to irradiate all the affected bony structures within a week or ten days and to repeat the treatment two or three times at intervals of from three to six weeks, depending on the quality of the rays.

TECHNICAL CONSIDERATIONS

The fact that malignant tumors so often affect the long bones of the extremities is a favorable circumstance, because it often permits more thorough irradiation with less systemic reaction than would otherwise be the case. Equally favorable is the increase in volume and therefore in the surface area of the affected part, because it permits irradiation through a larger number of fields than could be done if the size of the part remained the same. Often, however, the last factor is not sufficient to make an appreciable difference. On the contrary, the tendency of bone tumors to develop in children or young adults is an unfavorable factor, because the number or size of the fields of irradiation cannot then be so great as in the case of older patients.

The most important point is that, with the exception of hemangioma and perhaps of benign giant-cell tumor, the entire neoplasm and the tissues in its immediate vicinity should be exposed to the largest total dose of rays that can be given without undue jeopardy to the surrounding normal tissues and structures. To attempt to do this through only one or two fields usually results in failures or in inferior results. The scheme of irradiation best calculated to accomplish the desired result involves the concentration on the tumor of several beams of rays, all converging, from as many angles as possible, and on a common center which should correspond as accurately as possible to the center of the growth. By correlating the tumor with the physical landmarks and with roentgenographic measurements, it is usually possible to determine the center of the malignant lesion; this center should be indicated on the skin over two or more aspects of the affected region. A transverse line should then be drawn around the part in the case of an extremity. The superior and inferior halves of the region may then be subdivided into two, three or more fields, and these should be indicated on the skin by means of indelible lines. Each of the fields may then be exposed successively to the maximal permissible dose, usually on successive days; or all the fields may be exposed daily or twice a day to a small fraction of the maximal dose, and this may be continued for from 15 to 50 days. When the number of fields of irradiation in relation to the size of the affected part is large, due allowance should be made and the total dose per field should be reduced from 10 to 20 per cent. Absolute specifications cannot be drawn because these must necessarily vary with the circumstances in each case.

For example, if the tumor occupies the middle third of the femur and thigh, and the thigh is of average adult size, it may be irradiated through six fields, the size of which depends on the size of the thigh (Fig. 1). In the case of a child aged less than ten years, the number of fields would usually have to be reduced to four (Fig. 2) In the case of a tumor of the shaft of the humerus, six fields may be irradiated if the arm is large (Fig. 3). When the arm is small, only four fields can be effectively irradiated.

When the tumor is situated in the upper

part of the humerus, near the joint, especially when the affected part has greatly increased in size, the scheme of irradiation may be modified accordingly. The principles governing the method of treatment remain the same, but the method itself is modified so as to apply these principles most effectively (Fig. 4). When the problem is to treat a massive tumor of the scapula, it may be possible to arrange the treatment so that seven or eight beams of rays may effectively be concentrated on the growth, from the posterior, supraclavicular, axillary, and anterior (pectoral) aspects (Fig. 5). In this way rapid regression may be induced, and the tumor, especially if it be an endothelioma, may disappear completely in two or three months. The same general plan of treatment should be used for neoplasms of the bones of the lower extremities or pelvis (Fig. 6).

As for the relative advantages of protracted, fractional irradiation and irradiation within a week or ten days, the former may best be used in cases in which the malignant process is confined to a single bone, its radiosensitiveness is not high, and when evidence of metastasis cannot be found. Even then, the wisdom of extreme total doses is doubtful. For tumors that are relatively sensitive to irradiation, or for any tumor after metastasis has become apparent, protracted fractional irradiation is not advisable. For hemangioma, as has already been mentioned, a moderate dose of rays, repeated at intervals of about four weeks, is preferable.

The tendency of malignant tumors of bone to develop in children brings up a point which must not be lost sight of. Irradiation of the rapidly growing bones or muscles of a child is prone to retard, or may permanently interfere with the growth of these structures. The younger the child, the greater is the tendency of the rays to produce such an effect. Hence, excessive total dosage is to be avoided as much as possible. But when a neoplasm threatens the life of a patient possible interference with the growth of a bone and of the surrounding muscles constitutes a minor evil and may to some extent be disregarded. Nevertheless, the radiologist should be aware of this possibility and should impart his knowledge to the attending physician, the surgeon, or to a responsible member of the patient's family, in order to avoid ultimate disappointment and recrimination. Another point to which it may be well to draw attention is that, even in adults, excessive irradiation, after causing the tumor to regress, may interfere with the formation of callus or may lead to abnormal repair of bone, and this may mislead the physician into believing that the malignant process is still active when it is not. This is especially true after large total doses, such as may readily be given by protracted, fractional irradiation. For the reasons given, excessive irradiation, especially for giant-cell tumor, endothelioma, and hemangioma, should be carefully avoided.

Such is the approximate status of radiotherapy for tumors of bone, a status which reflects considerable improvement during the past few years. It is possible that the application of the principle of protracted fractional irradiation may lead to further improvement in the outlook for patients suffering from malignant neoplasms of the skeletal structures, especially from those varieties which, until now, have resisted treatment.

THE CLINICAL AND SURGICAL ASPECTS OF BONE TUMORS[1]

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THE physician should remember that certain tumors of bone may defy recognition in spite of excellent roentgenograms; moreover, the history, clinical and laboratory findings, even operation and microscopic examination have been known to fail to disclose the true nature of the growth, and sometimes the diagnosis has remained unknown until metastasis has occurred or necropsy has been performed. The roentgenogram has given the medical profession its greatest aid in diagnosis; in most instances, it permits determination of the true nature of the tumor and accurate prognosis. Such determination requires the experience of one familiar with the interpretation of roentgenograms—the expert radiologist and surgeon.

It has been my experience that tumors of bone present vague, early symptoms of mild pain or discomfort, that they usually affect young, healthy males, and that the first physician to be consulted by the patient is the general practitioner. Often, however, the condition is mistaken for a sprain or an infectious disease; the tumors are treated symptomatically and usually roentgenograms are not made until attempts to relieve pain and swelling have failed. Were it possible to give to every patient who complains of pain or swelling the benefit of early, expert service by a roentgenologist, I believe the presence of tumors would be discovered in time to make treatment more efficient and the prognosis better. To the family physician, the importance and value of early roentgenograms and consultation must be emphasized. The most valuable information will come through the co-operation of the clinician, roentgenologist, pathologist, and surgeon. The scientific investigation of cases of bone tumor, including careful follow-up records and presentation of conclusions, is a service offered by the Registry of Bone Sarcoma Committee.

Time will not permit full discussion of the interesting and often invaluable discoveries made in taking the history of the case, but long practice has given me an appreciation of the significance of history-taking in cases of bone tumor, and I recommend its usefulness to all interested in the subject. Although the history may disclose little of value unless one is accustomed to bring out facts and to evaluate them, it often clinches a diagnosis for the expert whose practice is constituted of a large number of cases of bone tumor. The history should elicit facts concerning the age and sex of the patient, and the situation, duration, and character of pain, if pain has been experienced. It also should embrace answers to questions concerning previous local trauma, including the following: fracture; previous diseases; previous treatment, including operations; remission of symptoms; local increase in temperature; tenderness; the presence or absence of tumor, and if a tumor is recognized, the rapidity of its growth. Of these, the age of the patient and the situation and rapidity of growth of any tumor that may be present probably are of greatest significance.

Pain or discomfort is usually the first symptom of bone tumor. It may be absent for months or years, and of a mild or rheumatic character if growths are benign. Malignant tumors are more painful. The pain usually is continuous, but there may be periods of remission; often trauma follows a period of freedom from pain and in turn is followed by re-activation of symptoms. In cases of primary tumor, pain remains localized; in cases of

[1] Read before the Radiological Society of North America, at the Twenty-first Annual Meeting, in Detroit, Dec. 2–6, 1935.

multiple benign and malignant tumor, it shifts, is of varying intensity, and often is confused with the pain of arthritis and neuritis. The roentgenologist should remember that pain is not always at the site of the tumor; it may be referred. I have encountered cases in which repeated roentgenograms had been made of the region of pain, but the true lesion remained undiscovered until careful physical examination or a roentgenogram of another region disclosed the site of the tumor. This is especially likely to occur if the tumors are in the spinal column or spinal cord. Pain results from intrinsic pressure, interference with the circulation, and impingement on the nerves. I have recently seen two patients who had tumors of the spinal column but the diagnosis was sacro-iliac strain. Lumbosacral or sacro-iliac strain, and arthritis with sciatic pain, when unrelieved by treatment, indicate the necessity of excluding the possibility of the presence of tumors involving the spine, before kyphosis and paralysis have taken place. The physician must remember that patients who have benign or maligant tumors, even at such advanced stages that metastasis has occurred, may appear to be in good health and of adequate weight, and may report for examination because of a condition which they consider to be a minor one, and of which the symptom is, as has been said, discomfort or pain of a varying degree.

Palpation and inspection of the region of the tumor, by the experienced physician, may permit diagnosis in a high percentage of the cases in which growths are in advanced stages. In cases in which the tumors are of the earlier, smaller, single types, the physician may be unable to discover anything of value and the same is true when tumors are of the multiple types. Careful inspection of the exposed extremities may reveal altered contour; palpation may disclose involved lymph nodes, metastatic tumors of the skin, or enlargement of bone. The skin in most cases of benign tumor remains freely movable, and stretches and thins with growth of the subjacent tumor. Cutaneous discoloration is usually the result of treatment; if tumors are of malignant types the skin may be purplish, more or less fixed, thin, and glistening, and venous engorgement is attributable to invasion of soft tissue. Motion of joints is limited earlier in malignancy than in the presence of benign tumor, because of more fixation of tissue and the proximity of the growth to the articulations. On palpation of vascular tumors, crackling may be elicited because of thinning of bone, and a bruit or pulsation caused by the rushing of blood may be detected. As compared with malignant tumors, the benign are, as a rule, less tender to pressure. Fluctuation is rare in uncomplicated cases of bone tumor but may follow degeneration, formation of cysts or clots, or surgical operation with resulting infection. Ulceration results from chronic irritation, extensive irradiation, surgical operation and, in the late stages, from protrusion of the growth. Local increase in temperature, which is common in cases of localized malignancy, often is absent in the presence of a benign tumor; giant-cell tumors are the principal exceptions. Measurements of the tumor, or of the circumference of the extremity, should be recorded for future comparison.

When the patient's history and physical examination have been completed, routine urinalysis, examinations of blood, and roentgenograms are indicated. Albumin is not uncommonly found in the urine, but the presence of Bence-Jones protein is particularly significant, and although this protein is found rarely in association with other lesions, its presence usually signifies multiple myeloma. Syphilis of bone is not always readily excluded, and flocculation tests and examination of spinal fluid are invaluable in distinguishing some otherwise confusing changes in bone from those caused by syphilis. The presence of syphilis does not exclude the possibility of sarcoma, and if doubt exists after careful clinical and serologic tests, exploratory operation and examination of tissue are indicated. The presence of a high total leukocyte count, and of a high percentage

of polymorphonuclear cells, aids in identifying inflammatory lesions of bone; moderate leukocytosis is not uncommon in cases of sarcoma, especially in cases of endothelial myeloma. Secondary anemia is so common a feature in many diseases as to be of doubtful diagnostic value; it is always present, however, in cases of advanced malignancy. The place of blood chemical studies in generalized skeletal disease is discussed elsewhere in this symposium.

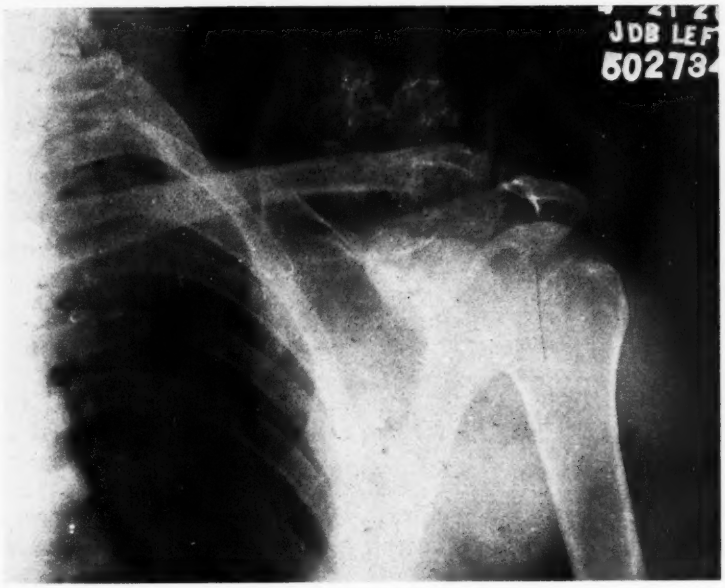

Fig. 1. Exostosis of scapula. The patient, aged 39 years, complained of aching pain and swelling over the left scapula of seven years' duration; in the three years preceding admission, the growth had increased rapidly. Complete excision was performed and the patient was well ten years later. The pathologist classified the tumor as an osteochondroma.

Surgeons seldom see the patients early, and the fact that consultation is sought makes it evident that a serious affliction is present. Often the destructive changes have become so extensive as to make surgical operation of questionable value. This is true not only of malignant bone tumors, but of benign tumors as well. I see patients with extensive deformities resulting from osteitis fibrosa cystica, giant-cell tumors, and even benign osteogenic types of tumor, which challenge the most expert attempts at removal of the growth and reconstruction of a useful extremity. Malignant tumors, such as osteogenic sarcomas, which have had various measures of treatment applied without noticeable effect, may give negative evidence of metastasis, yet it is obvious that the only surgical treatment which remains is palliative amputation. A surgeon who has made himself acquainted with the history of the patient, and who has made a thorough physical examination, then applies his knowledge to interpretation of the roentgenograms. He knows certain colleagues who have had large practical experience in this field and frequently and wisely he confers with them. Further roentgenograms taken at various angles, comparison of the shadows of the diseased bone with the shadows of the corresponding bone on the other side of the body, and with the shadows of other bones, including those of the chest, may be required, for the conscientious surgeon is not eager to operate

Fig. 2-*A*. Fig. 2-*B*.

Fig. 2. Multiple enchondromas of the metacarpophalangeal bones. The patient had noticed painless swelling of his hands since the age of two years: (*a*) before operation; (*b*) after excision.

unless he feels that surgery offers his patient the best opportunity of obtaining a good result.

It is not claimed that any one form of treatment infallibly will bring about cure of malignant lesions of bone, but it still is claimed, in the light of present knowledge, that surgical operation is the treatment of choice for primary benign and malignant tumors. If operation is performed, the pathologist is enabled to get tissue for classification of the type and degree of malignancy; also, the co-operating roentgenologist is given the opportunity to interpret his pre-operative findings and to judge the radiosensitiveness of the tumor in the region of which he will be asked to give post-operative treatment. I am fully aware of the diagnostic value of irradiation of endothelial myelomas and of giant-cell tumors, and of the radiosensitiveness of these types of growth; moreover, I am an advocate of radiotherapy for bone tumors. On the other hand, I believe we should know what we are treating when we employ radiation. Biopsy has been amply justified in my experience with tumors of unusual clinical and roentgenologic character. As a surgeon of open mind, as one who realizes the limitations of our diagnostic ability, as one also who appreciates that the roentgenogram permits the expert to diagnose correctly more than 90 per cent of cases, and that irradiation may be diagnostic and of great therapeutic value, I wish to express again the opinion that roentgen rays are one, if not the greatest, aid in diagnosis, and a considerable aid in treatment of bone tumors. The combination of surgical operation, irradiation, and administration of toxins apparently has given the best results in malignancy. The surgeon carries the responsibility in operating; he must take into consideration all the available data and, exercising his best judgment, he must decide on the procedure to follow.

Osteitis fibrosa cystica occurs most frequently among patients who are between the ages of five and twenty years. It is attended by little or no pain, and not unusually fracture following slight strain is the initial symptom. Palpation may disclose little or nothing that is significant; the skin appears normal but is slightly warmer than normal and the bone is enlarged. Usually, roentgenograms are positive; they display central areas in which absorption, with coarse trabeculations, appears to have destroyed bone, and to have caused thinning of the cortex without producing periosteal change other than thinning by bulging. Soft tissues are not invaded but, as the growth increases, it pushes its way through. Diaphyseal involvement is common; the epiphyseal line appears as a barrier, although it may be penetrated in later stages. Fractures heal

with little or no apparent callus and pain is usually not severe. In cases of long standing, skeletal support may be destroyed and marked deformity may be caused. For this reason I am not in favor of watchful waiting, but I prefer immediate destruction of the cystic portion by thorough curettage and, when indicated by the size of the growth, implantation of autogenous bone. Small cysts need only thorough removal by curettage. Always the possibility of the presence of the generalized form, the von Recklinghausen type or hyperparathyroidism, must be excluded by study of the general skeletal and blood chemical changes. Although some cysts may heal following fracture and fixation, it is wiser to operate in order to destroy the cyst and to make sure what pathologic process is present.

Giant-cell tumors are benign growths which commonly afflict young adults. Pain may be moderate, and a history of injury having occurred several months before discovery of the condition often is given. Fracture is not uncommon and I have seen cases in which it was the first sign. The most common sites of occurrence of giant-cell tumors are the lower end of the femur, upper part of the tibia, and lower end of the radius. The condition is closely related to the preceding one, osteitis fibrosa cystica, and is manifested, rarely, as multiple tumors; then, search must be made for hyperparathyroidism. Central and asymmetric absorption of bone is inclined to destroy the cortex, to cause bulging of the periosteum, and penetration of the periosseous tissues; trabeculations are absent or finer than they are in cases of osteitis fibrosa cystica. Extensive tumors may so destroy the epiphyses as to make surgical operation not only difficult but hazardous. Early discovery of small lesions usually permits cure in a minimal time, and with the least economic loss, by excision and use of the cautery. Larger tumors, in addition, may require autogenous bone grafts. Huge tumors occasionally destroy joints. Hemorrhage may require the surgeon to use a tourniquet and

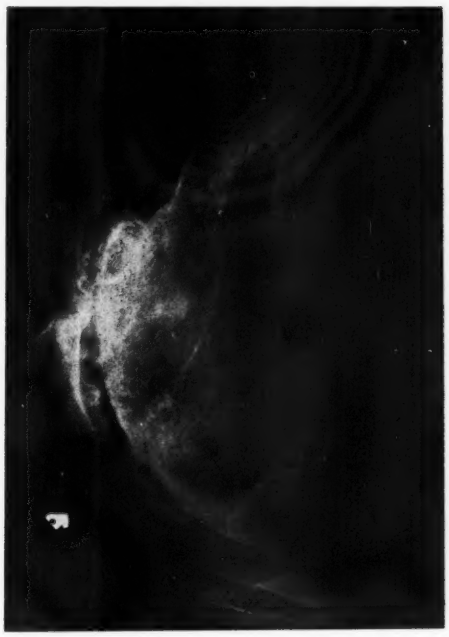

Fig. 3. Osteogenic sarcoma of the lower third of the femur. A man, aged 40 years, had sustained an injury to the lower part of the femur twenty years previously, and had suffered more or less pain and swelling since. He was 10 pounds (4.5 kg.) underweight at the time of consultation. Examination of the blood was negative. At operation, numerous loose bodies were found, and a section of bone removed was reported as showing the presence of osteitis fibrosa cystica. The patient returned in four months and complained of further swelling and pain. Amputation was performed and toxins were prescribed. He died of pulmonary metastasis ten months after amputation.

to pack the wound; this invites infection, and when it occurs amputation may become necessary. I remove tumors by curettage or excision and suture the periosteum. Post-operative irradiation is used in all cases when suspicion exists that tumor tissue may remain. Following careful and prolonged roentgenologic treatment, in some inoperable and apparently hopeless cases, I have been surprised and gratified when the tumor was completely replaced by new bone.

A benign osteogenic tumor, such as an osteoma, chondroma, osteochondroma, exostosis, or fibroma may exist for years without producing symptoms. These tumors commonly are discovered in youth, and when they grow they may impinge on

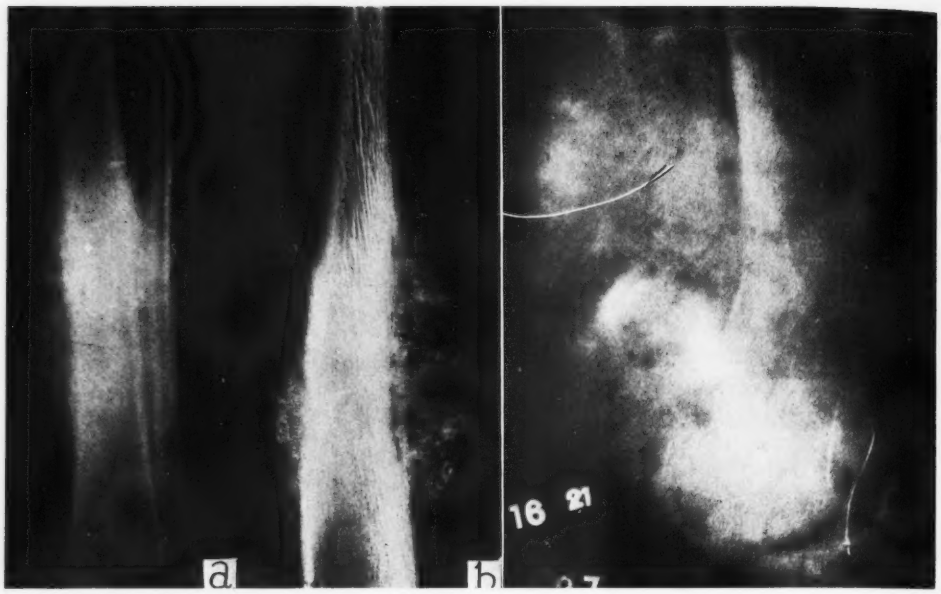

Fig. 4. Fig. 5.

Fig. 4. Osteogenic sarcoma of the tibia. A girl, aged 13 years, had a painless swelling of the left tibia and recalled having bruised the region twice, twelve and nine months prior to consultation. A diagnosis of sarcoma was made; amputation was performed through the lower part of the femur, and irradiation was employed post-operatively. The pathologist reported osteochondrosarcoma. Nothing was heard of the patient for several years and she was thought to have succumbed to metastasis, when she wrote in for advice. She had married, had a family, and apparently was in good health twelve years following amputation (Sarcoma Registry Case No. 296): (*a*) anteroposterior view; (*b*) lateral view after amputation.

Fig. 5. Sarcoma involving knee joint. A man, aged 21 years, in July, 1921, was brought to the Clinic on a cot after having been treated for rheumatism. His left knee was swollen, hot, and tender, and movement was markedly restricted. He remembered having injured the knee fifteen years before. He had noted some swelling for eight years, symptoms having been more severe in the five months preceding admission. The leukocyte count was 30,000, the value for hemoglobin 62 per cent, and roentgenograms revealed an apparent destructive arthritis. On aspiration of the knee, bloody fluid was found. The pathologist reported mixed-celled sarcoma of a high degree of malignancy, and a mid-thigh amputation was performed. Radium packs were applied over the stump and inguinal lymph nodes, and roentgen treatments were given to the chest, pelvis, and stump. Thirteen years later, the patient requested a report of his examination as he wished to take out insurance.

nerves or blood vessels, causing pain. Frequently the patient finds a painless bony projection at the end of a diaphysis; sometimes multiple lesions of exostosis are subsequently discovered in the roentgenograms (Fig. 1). These tumors are relatively insensitive to irradiation, and are best treated by excision, application of cautery to the base, and immediate closure. Recurrence is rare, although chondromas must be destroyed entirely or remaining cells will grow. Although microscopically these tumors appear to be benign, they assume grossly malignant characteristics (Fig. 2).

Multiple myeloma most frequently afflicts adults; in 60 per cent of a series of cases reported by me the patients were between the ages of forty and sixty years. It is a rare, generalized lesion in which the thorax, skull, and spine are principally involved by rounded or oval tumors which absorb bone. Pain is of a rheumatic, shifting nature, and periods of remission are not uncommon. Fracture of ribs, deformities of bone, and kyphosis occur. Anemia is usually present. Bence-Jones protein appears in most cases. Palpable, small, tender masses may be present in the ribs. The expectancy of life after diagnosis usually is from two to five years; surgical operation is of only diagnostic

value but irradiation may give temporary improvement.

Osteogenic sarcoma (Figs. 3 and 4) causes pain of varying degree. This tumor afflicts males more often than females, occurs at common sites of trauma, grows rapidly, and metastasizes to the lungs. Cures are reported to have endured for twenty years, yet the usual course is fatal, death occuring from metastasis. The surgeon may permanently rid the patient of the local growth if he follows early diagnosis with amputation. If amputation is combined with irradiation and the administration of Coley's toxins, improved results may follow. However, my results consist of only 18 per cent of five year cures (Fig. 5).

Endothelial myeloma is a highly malignant tumor that frequently is confused with, and treated as if the condition present were, osteomyelitis. It usually occurs before the twenty-fifth year of life, rarely before the fifth year, and it involves most frequently the shafts of the long bones, the femur, and the tibia, or the humerus. It produces intermittent pain which is worse at night. There is local increase in temperature, as well as tenderness and general temperatures as high as 104° F. In roentgenograms there may be evidence of diffuse thickening or destruction of the shaft of the bone. At times, onion-like layers of bone are seen parallel to the shaft, and more rarely spicules, osteophytes, extend from the shaft. Extensive involvement of the soft tissue often is evident. The differential roentgenologic diagnosis may be uncertain and the clinical signs confusing but the radiosensitiveness of the tumor is diagnostic. No other tumor responds so promptly and uniformly to radiotherapy. Coley's recent discussion indicates that a combination of amputation and administration of toxins has given the most certain results. I have reported a case in which a patient was well for more than five years following biopsy and irradiation; another is in good general health fifteen years following curettage, irradiation, administration of toxins, and finally, amputation. Metastasis produced death in my fatal cases in less than three years from the onset of symptoms. Future progress in the technic of irradiation should prove that, in this, if in any malignant tumor of bone, irradiation has curative value.

I believe that, in the future, irradiation will be found to have value unknown in treatment of tumors of bone. To justify scientifically any statement relative to the effects of any treatment, proof of eminent authority is required as to the diagnosis. Surgery, roentgenology, and expert microscopic study are available, and out of reports based on these factors, together with other contributions from those possessed of special knowledge, will come evaluation of the truth concerning therapeutic measures.

ROENTGENOGRAPHIC FEATURES OF SKELETAL AND EXTRA-SKELETAL LESIONS IN SOME DISEASES OF CHILDREN[1]

By ROGER L. J. KENNEDY, M.D., *Rochester, Minnesota*

From the Section on Pediatrics, The Mayo Clinic

MANY conditions of disturbed metabolism and disease in children are known to be accompanied by changes in the skeleton that are quite characteristic. Some of these conditions are of rather common occurrence, and in most instances the presence of changes in the skeleton can be predicted with reasonable certainty. In others, the condition is not so apparent and is disclosed only by roentgenologic study.

RENAL RICKETS

The roentgenographic appearances of the bones in cases of renal rickets have been described in some detail by Parsons. He divided cases into three kinds: (1) the atrophic type, with fragile, atrophic, osteoporotic appearances, lines of cancellous tissue at the epiphyseal ends of the dia-

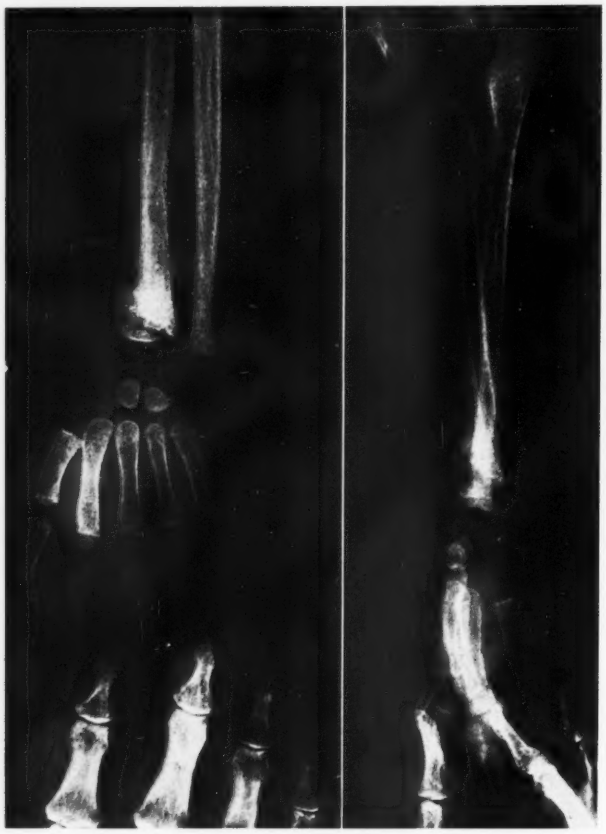

Fig. 1. Case 1. Renal rickets (woolly type—Parsons), showing the wide, irregular, moth-eaten appearance of the lower end of the radius and ulna. Some degree of osteoporosis is present. Delayed skeletal development is indicated by the presence of centers of ossification in only two carpal bones.

[1] Read before the Radiological Society of North America, at the Twenty-first Annual Meeting, in Detroit, Mich., Dec. 2–6, 1935.

physes, and a thin atrophic cortex and fractures of the shaft; (2) the florid type, with changes characteristic of florid rickets,

Fig. 2. Case 2. Renal rickets ("florid rickets"—Parsons), showing widening, irregularity, and cupping of lower ends of femurs and upper ends of tibias and fibulas, and widening of epiphyseal lines, changes typical of this form of renal rickets.

and (3) the woolly, stippled, or honeycomb type, with swollen epiphyseal ends of the shaft and a honeycomb, stippled, or woolly appearance of this portion of the bone. The bone looks moth-eaten and the changes suggest those of osteomyelitis or syphilis. The metaphysis extends over a much greater area than in ordinary rickets. There is some osteoporosis, but the cortex is not as thin as in the atrophic type. The skull may show changes identical with those of Paget's disease. Metaphyseal changes may not be uniform in all bones.

According to Parsons, the primary cause of renal rickets is the inability of the kidney to excrete phosphate properly. The pathogenesis of renal rickets and its relation to renal disease, hyperparathyroidism, infantilism, and polyglandular affections, and the disturbances of mineral metabolism involved, have been discussed by Parsons, Shelling and Remsen, Hubbard and Wentworth, Mitchell, and others. The problem is still unsolved.

Case 1. A boy, aged three years, was brought to the Clinic because of inability to walk and deformities of the extremities. His disability had developed when he was one year of age and had not been accompanied by pain. He had polyuria and polydipsia.

He was obviously small for his age. Examinations and tests revealed changes characteristic of chronic interstitial nephritis, renal dwarfism, and renal rickets. The specific gravity of the urine was from

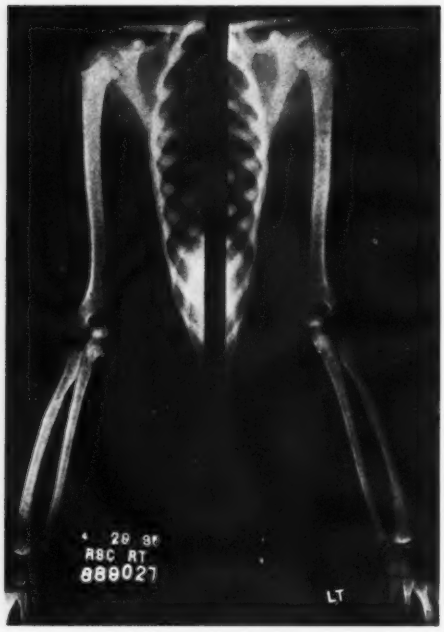

Fig. 3. Case 3. Renal rickets (atrophic type—Parsons), showing thin gracile bones and retarded development indicated by only four and five centers of ossification in the carpal bones.

1.005 to 1.007. He was unable to concentrate urine to a specific gravity of more than 1.010. The excretion of phenolsulphonphthalein was 15 per cent in two hours. An attempt was made to secure an intravenous urogram, but none of the media was excreted in two hours' time. The value for urea was 114 mg., for calcium 9.5 mg., and for phosphorus 6.6 mg. per 100 c.c. of blood.

Roentgenograms (Fig. 1) of the bones revealed diffuse osteoporosis. The ends of the long bones appeared wide and moth-eaten. The epiphysis, and in some of the bones the epiphysis and a portion of the metaphysis, appeared to be displaced and separated from the diaphysis. Retarded development was indicated by the presence of only two centers of ossification in the wrists.

This case, therefore, is an example of the woolly type of renal rickets of Parsons.

Case 2. A boy, aged eight years, was brought to the Clinic. He had failed to grow, and had polyuria, polydipsia, anemia, jaundice, and clouding of the cornea. The attention of those who had seen him previously had evidently been focused chiefly on the jaundice and his small stature. He had been treated with a number of endocrine preparations. Examination revealed findings characteristic of chronic interstitial nephritis and renal dwarfism.

Roentgenograms showed the sella turcica to be larger than normal. There was generalized skeletal osteoporosis and the skull revealed a finely granular appearance indicative of osteoporosis, as described by Camp. The cortical bones were thickened. The diaphyseal ends were widened and there was widening and fuzziness of the epiphyseal lines (Fig. 2). The wrists exhibited centers of ossification in two carpal bones on one side and in three on the other.

This case exemplifies the "florid rickets" type of renal rickets as described by Parsons.

Case 3. A girl, aged eight years who had all of the features characteristic of interstitial nephritis and renal dwarfism. Roentgenograms (Fig. 3) revealed that all the long bones were thin and gracile. The diaphyses of the femurs were slightly thickened. The development of the centers of ossification was delayed.

This case represents Parsons' atrophic type of renal rickets.

XANTHOMATOSIS

The roentgenographic appearances of xanthomatosis or the Christian-Schüller syndrome in infants and children are now quite well known. Although the lesions in the skull may be confused with myeloma, chloroma, and metastatic malignant disease, other features, such as the exophthalmos, diabetes insipidus, and involvement of other bones (16), confirm the diagnosis. An interesting example of this is the following case.

Case 4. The left eye of an infant, aged ten months, had three months previously begun to protrude. Palpable masses ap-

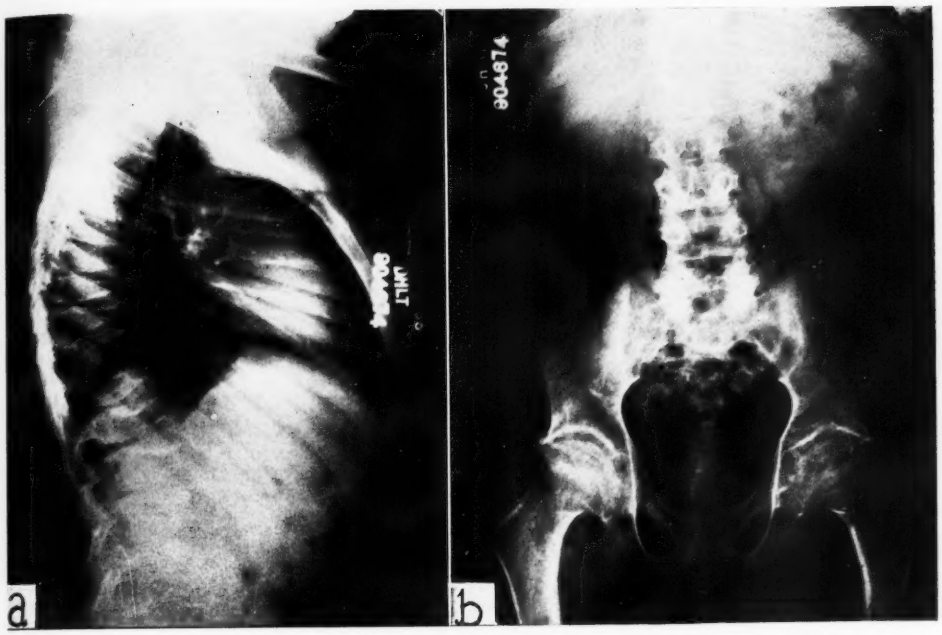

Fig. 4. Cases 5 and 6. Osteochondritis juvenilis: *a*, deformity of bodies of vertebræ characteristic of Scheuermann's disease; *b*, osteoporosis and deeping of acetabular cavities.

peared on the head. Roentgenograms of the skull when the child was ten months of age had been negative. At 29 months of age, a roentgenogram revealed multiple cystic areas throughout the bones of the skull. These were thought at first to represent malignant disease and radium was applied. The lesions receded but others appeared in other bones as well as in the skull. The course was prolonged. The disease involved most of the bones of the body, and both reparative and destructive processes were observed at the same time. For a long time the child's condition appeared quite hopeless. Radium therapy was continued and it was noted that the treated lesions healed rather promptly. Eventually, new lesions stopped making their appearance. Healing became complete, and, by the time the boy was five and a half years of age, he had made a very satisfactory recovery.

MULTIPLE MYELOMA

Multiple myeloma is uncommon among children. Slavens reported a case from The Mayo Clinic in which the patient was under observation for a year. Necropsy was performed and the nature of the lesions proved. The boy was four years old when first examined. A roentgenogram of the skull revealed multiple regions of destruction. Roentgenograms of the hips and spinal column showed a compression deformity of the first and second lumbar vertebræ and irregular mottling of the bones of the pelvis, with symmetrical areas of rarefaction in each acetabulum. Nine months later roentgenographic examination revealed greatly increased destruction of the vertebral bodies. The pelvic bones and skull were more extensively involved with the tumor.

The disease is invariably fatal. Bence-Jones protein was not found in the urine in this case. Bannick has found that, in about 30 per cent of cases of proved multiple myeloma, Bence-Jones protein was absent from the urine. The differential diagnosis in well-developed or advanced cases should not be difficult from the roentgenographic appearances. Chloroma, xan-

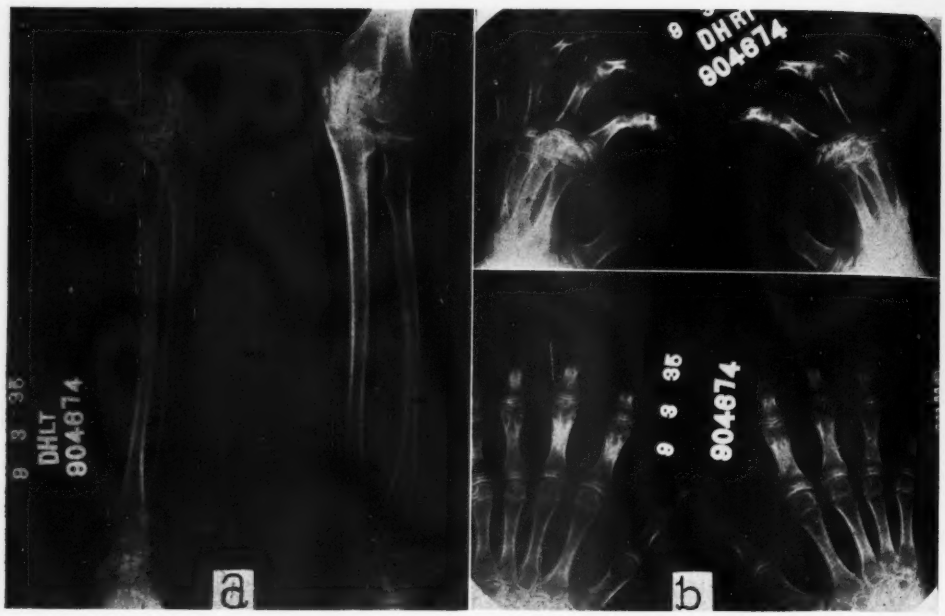

Fig. 5. Cases 5 and 6 (*a* and *b*), showing widening of the ends of the bones, including phalanges.

thomatosis, and multiple areas of osteomyelitis may have to be considered, but their characteristics differ sufficiently from those of myeloma so as to make diagnosis quite certain.

OSTEOCHONDRITIS JUVENILIS

There is a group of conditions encountered in children that may be included under the general term "osteochondritis." The etiology is unknown. They are frequently progressive in character and result in various degrees of disability. Two very interesting cases were recently observed, the patients being brothers.

Cases 5 and 6. Two brothers, aged 11 and 13 years, respectively, had nearly identical histories, and the physical, laboratory, and roentgenographic findings were also nearly identical. After learning to walk they had become bow-legged. The joints of their fingers, elbows, knees, and ankles had enlarged and motion in them became limited. Later, the hips had become involved. The gait then became flat-footed and waddling. The significant findings in the roentgenograms were in the spinal columns (Fig. 4-*A*), hips (Fig. 4-*B*), knees (Fig. 5-*A*), ankles, elbows, and wrists (Fig. 5-*B*). The spinal columns revealed the characteristics of Scheuermann's disease, with irregular outlines of the vertebral bodies and so-called epiphysitis. The ends of the long bones were widened. The hands were claw-like owing to limitation of extension and flexion and widening of the ends of the phalanges.

Eckardt stated that there are two schools of thought concerning Scheuermann's disease. According to one, it is a disturbance at the line of growth between the bodies and the epiphyses of the vertebræ, resulting in wedge-shaped vertebræ. According to the other school, it is due to changes in the surface borders of the vertebræ, the changes in the epiphyses not being essential. It was Eckardt's opinion that the cause, whatever it may be, is the same as in Calvé-Perthes disease, and that the only difference between the two conditions is a difference in the sites involved. A somewhat similar case observed is described in the following case history.

Case 7. A girl, aged ten years, came

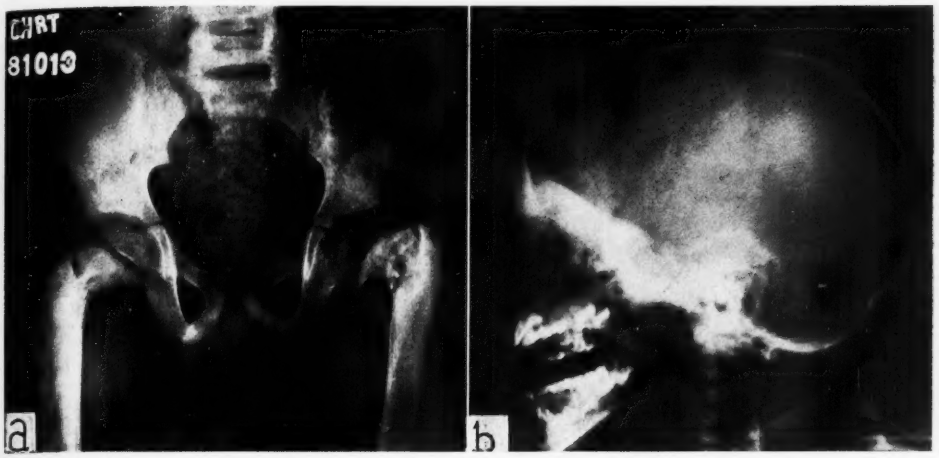

Fig. 6. Case 8. Unclassified osteodystrophy: *a*, coxa vara with pseudo-fracture due to bands of osteoid tissue; *b*, osteitis of base of skull, involving chiefly the sphenoid bone, floor of anterior fossa, left temporal bone, and region of the frontal sinuses.

under observation because of stiffness of the joints of her hands, wrists, shoulders, hips, and spinal column, which had developed when she was three years of age. Motion was limited, the gait was stiff, and there was a swinging motion of the hips. Roentgenograms disclosed fragmentation of the upper half of both patellæ, epiphysitis of the spinal column, and bilateral epiphysitis and roughening of the cartilage of the acetabular cavity. The diagnosis was probably osteochondritis, but there was some evidence of previous osteoporosis as indicated by the narrowing of the pelvis from side to side.

CLOUDY CORNEA SYNDROME

Helmholz and Harrington described a syndrome with cranial dysostosis which they termed the "cloudy cornea syndrome." It may belong in the same general group as osteochondritis. The characteristics are cloudiness of the cornea, restricted motion of the joints of all extremities, short thick claw-like hands and feet, and limited extension, lumbar kyphosis, scaphocephalic head, and mental retardation.

The roentgenograms in Helmholz and Harrington's cases (Cases 1 and 2) disclosed kyphosis, with deformity of the vertebral bodies, roughening of the lower ends of the radius and ulna, delayed development of the carpus, and evidence of old rickets. Roentgenograms of the head gave evidence of a slight degree of increased intracranial pressure.

CASES OF INVOLVEMENT OF BONE IN WHICH A DEFINITE DIAGNOSIS WAS NOT MADE

Not all cases of involvement of bone are easy to classify. For example, the following case.

Case 8. A boy, aged six years, was brought to the Clinic because of shortening of the left leg, a condition which had developed eleven months previously, and also because of an apparent downward displacement of the left eye which had been present for about the same length of time. He had had no pain. The left leg was 3 cm. shorter and 1 cm. less in diameter than the right. Roentgenograms revealed bilateral coxa vara, resulting from softening of the necks of the femurs, and areas of pseudo-fracture, apparently resulting from bands of osteoid tissue (Fig. 6-*A*); delayed development of centers of ossification in the wrist; increased density of the middle third of the bones of the left leg, due to cortical thickening; some bowing of the tibia and fibula; normal

Fig. 7. Case 9. Hyperosteitic osteopathy, showing marked increase in width and density of cortex of middle two-thirds of femurs, tibias, and fibulas, with little change in metaphyses and epiphyses. Periostitis is also present. The upper extremities and the skull were also involved.

epiphyseal lines; extensive diffuse osteitis of the skull, involving particularly the left sphenoid bone, the floor of the anterior fossa on the left, and the left temporal bone and the region of the frontal sinuses (Fig. 6-*B*). There was no absorption of bone to indicate decalcification. A portion of bone removed from the right tibia evinced changes characteristic of osteitis fibrosa cystica.

Although there were some features in this case that suggested osteopsathyrosis and others that indicated osteitis, a diagnosis other than osteodystrophy was not made.

HYPERPARATHYROIDISM

Hyperparathyroidism has in recent years been the subject of intensive study and much discussion. It probably does not affect children very frequently. Pemberton and Geddie reported a case of hyperparathyroidism affecting a girl aged 14 years. Her history was quite typical, and the physical examination and laboratory findings supported the diagnosis of hyperparathyroidism. The roentgenogram revealed diffuse decalcification of all the bones and a cystic area in the upper portion of one femur. Roentgenograms of the knees, made a month after removal of a parathyroid adenoma, gave evidence of recalcification, and a roentgenogram of the skull made about three years later revealed a normal condition of the bone.

MULTIPLE HYPEROSTEITIC SCLEROSING OSTEOPATHY OF INFANCY

Engelmann has described and differentiated one condition which he called "osteopathia hyperostotica (sclerotisans) multiplex infantilis." An instance of this disease was observed in the following case.

Case 9. A boy, aged two and a half years, about a year before he came under observation, had begun to drag his right leg, which gave him a shuffling gait. He tired easily and began to exhibit a dislike for walking. On physical examination his bones seemed to be markedly enlarged, both in length and thickness. The roentgenographic appearance of the bones was identical with that in Engelmann's case. The shafts of the long bones were markedly thickened and the periosteum was greatly elevated (Fig. 7). Bilateral symmetrical osteitis and periostitis was present which involved the middle two-thirds of the shafts of the femurs, tibias, fibulas, radiuses, and ulnas. The bones of the skull were markedly thickened. The questionable diagnosis of hypertrophic endosteitis or juvenile form of Paget's disease was changed when Engelmann's contribution was discovered.

According to Engelmann, there is dif-

fuse bilateral involvement of the shafts of the long bones, without definite demarcation between affected and unaffected portions. There may be somewhat more extensive involvement of the distal parts, as in the femur and humerus, or somewhat more pronounced involvement of the proximal parts, as in the radius, ulna, and tibia. The ends of the shafts and the epiphyses are normal. He listed the changes in detail as follows: (1) thickening and hyperostosis; (2) sclerosis (both of these changes involving the entire cross-section and circumference of the bone, the surfaces being smooth, the thickened portions appearing flecked or spotted, and the medullary cavity being widened); (3) lengthening of the bones; (4) some bowing, and (5) thickening of some portions of the skull, usually the anterior and basal portions, including the frontal and petrous portions of the temporal bone, the middle fossa, and the anterior fossa, particularly the roofs of the orbits. The calvarium is usually thinned, and the sella is usually small. The chest, spinal column, and pelvis are approximately normal.

Fig. 8. Case 12. "Phosphosklerosis" (Gottesleben), showing dense transverse lines at ends of the long bones and concentric lines in the carpal bones. In addition, there were concentric lines in the bones of the pelvis, vertebræ, and in other bones.

CALCINOSIS

Deposits of calcium salts in various tissues and organs of the body are not uncommon. Widespread deposits in the skin and subcutaneous tissues have been discussed by Basch and by Durham. Aisenberg reported a case similar in all respects to one which I reported (12).

Case 10. A girl, aged six years, when first seen had marked limitation of motion in most of her joints, particularly the hips, knees, elbows, and shoulders. Roentgenograms revealed widespread calcification of the skin and subcutaneous tissues. One and a half months after having been given the ketogenic diet, there was a noticeable decrease in the amount of calcareous material in the region of the hips and the child was walking better and with greater ease. The ketogenic diet was adhered to for three and a half years. At the expiration of that time genu valgum was present, and there was slight awkwardness of gait but no demonstrable limitation of motion of the joints. Roentgenograms of the pelvis, spinal column, and axillæ were negative, the calcareous deposits having entirely disappeared. Roentgenograms of the knees gave evidence of a few small masses of calcareous material; there was also a slight increase of calcium in the proximal end of the diaphyses of both tibias.

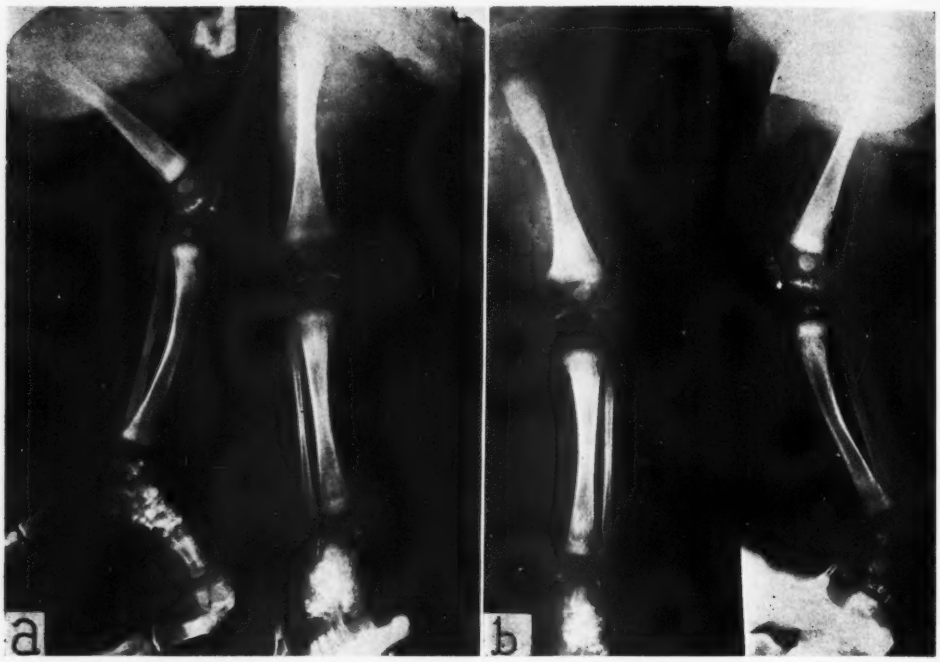

Fig. 9. Case 13. Calcareous deposits in articular surfaces of joints; *a*, right; *b*, left. The symmetrical distribution of calcareous material in right and left lower extremities will be noted.

INCREASED DEPOSITS OF CALCIUM IN THE SKELETON

Regions of increased density in the bones of children may arise from a number of causes and may exhibit a variety of appearances. Two rather striking and unusual cases have been observed.

Case 11. A child, aged two and a half years, was brought to the Clinic for examination because of failure to gain properly, the girl having been slow in learning to sit, stand, and walk. Later she became active and apparently healthy. Roentgenograms of the spinal column showed mild calcification of the fifth and sixth thoracic intervertebral discs and slight calcification of the third thoracic intervertebral disc. The next case was perhaps more striking.

Case 12. A boy, aged five years, was brought for examination because of vasomotor rhinitis. The history was negative. Roentgenograms disclosed well-defined lines of increased density, corresponding in number to years of the patient's age, in the proximal and distal portions of the tubular bones of the upper and lower extremities (Fig. 8). There was stratification of all epiphyses of the carpal bones and of the bony units of the innominate bones. The roentgenograms were identical with those in the case reported by Gottesleben, in which he termed the condition "phosphosklerosis" because of the probable relation of the lines to periods of increased intake of phosphorus.

DEPOSITS OF CALCIUM IN THE ARTICULAR SURFACES OF THE JOINTS OF AN INFANT

A most unusual instance of calcareous deposits was observed recently.

Case 13. The patient, an infant, had been delivered by Cesarean section. The maternal and family histories were negative. At four weeks of age, a slight swelling was noted on the dorsum of the left wrist. Two weeks later, a firm mass appeared on the thenar eminence of the right hand. In the roentgenogram this was found to be opaque, and multiple

irregular areas of calcification were found in each of the carpal regions, and a large area of calcification was found extending up between the left radius and ulna. Roentgenograms were then made of the entire skeleton, and multiple small areas of calcification were seen in the joints of the carpus, shoulder, hips, knees, and tarsus (Figs. 9-*A* and *B*). The calcification in the joints was bilaterally symmetrical and seemed to follow rather closely the outlines of the articular surfaces. Study of the chemical constituents of the blood failed to reveal any significant departure from normal. The mass on the right thenar eminence increased in size and spontaneous extrusion appeared imminent. It was removed surgically and was found to contain calcium phosphate only. Roentgenograms when the infant was five months of age revealed little if any change in the appearance of the deposits of calcium.

CONCLUSIONS

These cases have been presented because: (1) they represent some of the problems that must be solved by the cooperative efforts of the pediatrist, orthopedist, and roentgenologist; (2) they exemplify some of the conditions which occur only uncommonly in children, and (3) they emphasize the fact that, in many conditions, knowledge concerning etiology and pathogenesis is incomplete.

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DISCUSSION OF SYMPOSIUM ON LESIONS IN BONE

DR. R. R. NEWELL (San Francisco): I do not know whether I am merely a vain theorist or whether I am only lazy, but I do want to express a doubt as to the usefulness of dividing up the dosage into so very many parts.

I cannot help being impressed by the way those beams of radiant energy are going to cross within the body of the patient, leading to an increase in dosage in certain crossed areas, and a failure even so much as to double the dose in other regions where the beams do not cross so many times.

I have a belief that successful radiation therapy depends upon evenness of radiation through the body rather than in overdosing one part of the tumor and letting other parts escape.

DR. LEUCUTIA (Detroit): I feel it to be a rare privilege to be able to listen to the papers presented in such an able manner as they have been by Dr. Sutherland, Dr. Meyerding, and Dr. Desjardins in this symposium. The procedures which were considered now represent standard methods and there is very little that I can add in the form of a discussion.

I would like to use this rare privilege, however, to ask for your indulgence to present a case which is rather unusual and may serve to shed light on some of the problems brought out.

It is that of an osteogenic sarcoma of the ilium—diagnosed as such in 1921. The chief roentgen manifestation was destruction, and the osteogenic sarcoma was classified as osteolytic in type, a fact which indicated a very high degree of radiosensitivity. Microscopically, the picture was dominated by round cells of a very malignant character, with many blood vessels throughout the tumor. Other fields presented spindle cells, likewise of highly malignant nature. This patient received therapy very much in the form as described by Dr. Desjardins, in the Spring of 1921, and there was complete disappearance of the tumor following the therapy. In the late Fall of 1921, however, a roentgenogram of the chest revealed very diffuse nodular metastases to both lungs. Radiation therapy was administered over the lungs just before Christmas of the same year. The tumors all disappeared within a period of six weeks and there was a rather pronounced pneumonitis which we thought was due to the radiation reaction. Within another three months the pneumonitis also cleared up and at the present time, thirteen years later, the patient is entirely well and the appearance of the chest is normal.

This case represents an unfortunately singular occurrence and we must confess that we have not been able to duplicate the result.

As Dr. Desjardins has brought out in his paper, a tremendous improvement has been brought about in the field of radiation therapy. However, if we consider only the highly malignant osteogenic sarcoma group, then, of course, the percentage of ultimate results is still rather small, and we must admit that this chapter of medicine still represents one which is worthy of further investigation and study.

DR. LAWRENCE REYNOLDS (Detroit): I am sure you have all enjoyed Dr. Camp's very interesting discussion of this great group of diseases which are so prevalent. As he said, the roentgenographic findings are sometimes quite significant and at other times they are not.

In conversation yesterday with one of the leading orthopedic surgeons in the city, he and I agreed there were three conditions we did not know much about, among many others: bone tumors, malacic disease of bone, and scoliosis.

We are confronted with a bone tumor. The question arises, Is it or is it not malignant? When confronted with malacic diseases of bone, the questions arise, What disease is it? And what is the disturbing factor in that particular disease?

You have heard from Dr. Camp a very splendid description of the various types of malacic diseases. I had hoped that in this discussion he would give us some real explanation for some of the fundamental causes of these disease processes. As he so aptly said, the one disturbance associated with hyperparathyroidism is well known to all of you. Its differentiation from other diseases, however, is not so well known.

He failed to take up in the first part of the paper the question of atrophy—atrophy of disuse and the extreme atrophies which follow apparently trivial injuries to the wrist, first described by Sudeck. It is disabling beyond anything which one might find in the roentgen examination

and the patient exhibits a certain amount of glossy appearance of the skin and disturbance of circulation. I wish Dr. Camp had taken that question up in more detail.

He passes very lightly over the question of rickets. I am sure that pediatricians who will follow in this discussion will tell you that there is a lot we do not know about rickets.

The gross appearance of rickets is well known, of course, but the early changes which occur in the roentgenogram are the most important factor, I believe, in the diagnosis of rickets. What are the early changes of rickets? You have only to sit down with three or four roentgenologists, two or three chemists, and a pediatrician and put the films up and see the great variation in their opinions as regards early rickets.

So I hope this Society at some future meeting will have a complete symposium on rickets, including pathologic specimens, bringing out the work that has been done by Dr. Hess, Dr. Elliott, Dr. Parks, and many others. Sometimes I think we pay too little attention to the commoner diseases; we are seeking for some bizarre disease and we pass over the things that we see every day.

Renal rickets is a relatively rare disease. It produces bone changes similar to those in ordinary rickets. The cause of it has never been determined. It is agreed among clinicians, I think, that renal insufficiency precedes the bone changes. I was much interested some time ago in seeing that two English observers had called attention to the presence of congenital valves in the ureters of two cases that came to autopsy with a diagnosis of renal rickets. I call that to your attention because the disease is relatively rare; very few of us will ever see more than one case, if any at all, and if you have an opportunity to perform an autopsy on one of these unfortunate children, be sure that the urinary system is carefully examined for the question of some obstructive congenital lesion along its path.

If you have a chance to study the case before autopsy, it might be well to do some intravenous examination in the hope that you might demonstrate an obstruction in the urinary system.

It is impossible, in the short period of time available, to discuss the other parts of this splendid paper.

Dr. Camp, in the last group in his discussion of focal cystic changes, showed us films which simulated very much the type change we see in Ollier's disease. It has been my privilege to see two cases of Ollier's disease in children. We have followed these cases, one for a period of almost ten years now. One of these children had her parathyroid removed. The disease process has stopped completely. The other child's mother refused to have the parathyroid removed. That child has shown a definite progression in her disease process.

So focal osteitis fibrosa cystica may be associated with parathyroidism or at least there is the possibility that Ollier's disease, which is quite similar, may be associated with parathyroid disturbance.

Dr. Camp did not take up the question of Paget's disease and I am very sorry I did not hear the speaker who preceded me. The question arises as to whether or not there might not be some disturbance in sugar metabolism. Some work done by Dr. Moehlig and others working with him would seem to indicate that sugar metabolism plays an important part in some of these bone dyscrasias, and a study along that particular line might add a great deal of information to a somewhat obscure subject.

PATHOGENESIS AND RADIOTHERAPY IN CARCINOMA OF THE THYROID[1]

By ISAAC LEVIN, M.D., *New York City*

THE pathogenesis of carcinoma of the thyroid differs radically from that of carcinoma in other organs. The progressive pathologic changes in the thyroid gland pass imperceptibly from hyperplasia into simple benign or functional benign neoplasia, and further into malignant neoplasia.

Even in a normal thyroid there is a tendency for wide dissemination of thyroid acini, as noted in certain fish, and a general enlargement of the whole organ may take place in the course of normal pregnancy or may be induced by changes in diet or by drugs. At least the endemic prevalence of goiters in certain localities is ascribed to lack of assimilation of iodine. Once such a hyperplasia has taken place it frequently changes in the whole organ or in some parts of it into a true benign neoplasia.

Thus, the enlargement of the thyroid in *colloid goiter*, the most common type, is due to the distention of normal alveoli with colloid, and there is no evidence of any neoplasia. Very frequently, however, in many regions of the goiter, neoplasia of the epithelial cells and formation of new alveoli take place, but this neoplasia remains a *benign adenoma*.

In *exophthalmic goiters*, the enlargement of the thyroid is due to a reflex hypertrophy, and is rarely accompanied by true neoplasia, either benign or malignant.

In *adenomatous or nodular* goiter, the thyroid is generally not enlarged but shows one or several nodules within a normal thyroid. These nodules present a true benign neoplasia from their inception.

It is generally accepted that *carcinoma of the thyroid* does not develop in a normal gland but within a region of a benign neoplasia. Frequently, a benign goiter is present for many years before a carcinoma develops. The malignant transformation takes a very insidious course, and presents in its incipiency no manifestations, either morphologic or clinical. The pathogenic relationship between the benign and malignant neoplasia in the thyroid is thus closer and more evident than in any other organ, and the thyroid, therefore, is the most favorable organ for the study of this relationship.

Diagnosis of the early stages of carcinoma of the thyroid presents great difficulties. The malignant portion is generally located within the capsule of a benign adenoma, cannot be palpated, and adds nothing clinically to the symptom-complex of the benign goiter. When the carcinoma in its further development breaks through the capsule, invades and becomes adherent to the surrounding tissues of the neck, then the clinical diagnosis becomes simple, but this transformation takes place only in the late stages of the disease.

Microscopic diagnosis, even in a surgically removed gland, is extremely difficult in view of the great morphologic variations of the tumor tissue and its close resemblance to the tissue in non-malignant neoplasia.

Whenever a goiter is removed surgically in a person of cancer age, and active proliferation of epithelial cells even in an incapsulated tumor is found, the possibility of early malignancy must be kept in mind.

The diagnostic difficulties described above make it quite plausible to assume that carcinoma of the thyroid occurs much more frequently than the clinical statistics would seem to indicate. The truth of this assertion can be well illustrated in the study of skeletal metastases in carcinoma of the thyroid.

Following carcinoma of the prostate and of the breast, carcinoma of the thyroid most frequently metastasizes in the skeleton. Berard and Dunet (1), in their re-

[1] Read by title before the Radiological Society of North America, at the Twenty-first Annual Meeting, in Detroit, Dec. 2-6, 1935.

cent analysis of the subject, found the frequency of skeletal metastases in carcinoma of the thyroid to vary between 18, 30, and even 70 per cent of all cases. On further analysis of 110 cases of skeletal metastases in carcinoma of the thyroid they found that the most frequent sites of the metastases were the skull and the vertebræ.

There are several characteristics in the secondary metastatic tumors of carcinoma of the thyroid which make them the most favorable material for the study of the general problem of metastasis formation.

Ewald (2) showed the presence of iodine in metastatic adenocarcinoma of the thyroid, while the original tumor was free from iodine.

A simple colloid goiter, presenting a structure that usually remains harmless for years, may give rise to metastatic tumors. These secondary tumors may acquire the characteristics of malignancy though the primary tumor remains benign.

Riedel (3) removed a tumor of the inferior maxilla, composed of normal thyroid tissue. The tumor, however, recurred locally after ten years.

In order to elucidate these apparent peculiarities in the formation of metastasis generally, and particularly of skeletal metastasis in carcinoma of the thyroid, a brief survey must be made of the mechanism of formation and pathogenesis of metastasis in carcinoma generally.

The writer (4) studied the problem experimentally and clinically. He also analyzed microscopically a large number of cases of skeletal metastasis. The conclusions reached from this combined study do not always coincide with the opinions of the investigators of purely anatomic material.

Two processes always take place side by side in skeletal metastases. On the one hand, the tumor destroys the normal bone tissue; on the other hand, the remaining osseous tissue proliferates and creates new bone. The latter is quite probably an attempt at self-defense. The new bone tissue may compress and destroy the cancer cells.

The minute microscopic study of skeletal metastases gives the clearest evidence of the interaction which always takes place between the normal organ tissue and the cancer cells during the beginning of the development of a metastatic tumor from a transported cancer embolus. Upon the result of this interaction depends the success of metastasis formation.

This conception of the pathogenesis of formation of metastases may well serve to clarify the meaning of the peculiarities encountered in the metastases in carcinoma of the thyroid. It is impossible to conceive that a normal cell of the thyroid, or a cell of a benign goiter, when transplanted into a bone may form a malignant tumor. On the other hand, it is often difficult to differentiate morphologically between a benign and a malignant tumor of the thyroid. It was stated above that the failure or success of the development of a metastatic tumor from a transported embolus depends upon the interaction between the normal organ tissue and the cancer cells.

We may conceive that a small group of cells of a normal thyroid or of a benign goiter may become malignant, but the thyroid or goiter offers an unfavorable soil, and suppresses the further development of a malignant tumor for a longer or shorter period of time. The same small group of malignant cells, when severed from the primary locus and transported to bone, may find there a more favorable soil and develop into a large, actively growing metastatic carcinoma. Moreover, these cancer cells may not only increase its power of proliferation but may also increase its functional capacity. Thus, Ewald noticed that iodine is produced in the metastatic tumor while none is produced in the primary tumor.

Cases in which the primary tumor in the thyroid is small and not malignant clinically, while the metastatic tumor is large and very highly malignant, are encountered frequently in carcinoma of the thyroid.

This is of importance theoretically and practically. The whole symptom-complex

is caused by the metastatic tumor; therefore, the primary condition is frequently overlooked and both the diagnosis and therapy may be wrong.

The cases of skeletal metastases in carcinoma of the thyroid reported here all belong to this type.

CASE REPORTS

Case 1. *Clinical History.* M. B., white male, aged 31 years, was seen at the clinic in 1924, suffering from epithelioma of the ear. He disappeared and presented himself again three years later.

At this time the original condition seemed to be improving. About nine months later an insidious painless swelling arose over the region of the right clavicle. This condition grew slowly but gave the patient no discomfort. Three months later, the patient began to complain of a cramp-like pain in the region of the spine. This pain occurred in the daytime, usually at the onset, and was brought on by change of position. In addition to this, the patient complained of pain in the upper back between the shoulder blades. During this time there was also noted some loss of weight.

Two months later the patient noticed a a lump in the occipital region. Other lumps arose in the region of the scalp. At the same time the patient noticed shooting pains in the legs, originating in the spine. Gradually, power in the lower extremities began to disappear, first on the left side and later on the right.

Physical Examination.—General appearance was that of a young adult male, about 30 years of age. He presented an anxious expression and appeared to be suffering from recurring pains. He appeared anemic and cachectic.

The right ear was distorted and much smaller than the left. The skin behind the ear was depressed, soft, and smooth. The external auditory meatus was occluded by a flat ulcerated neoplastic area, 12 by 8 mm. in extent. This area bled readily to the touch, and was pinkish in color and granulation-like in appearance.

Anteriorly, the chest showed a distinct flattening in the region of the nipples. The clavicular regions showed an asymmetry, the right clavicle being much more prominent. On palpation, the clavicle was found to be replaced by a soft, elastic, smooth mass about 6 by 3.5 cm. in extent. On palpation, the left clavicle also presented many protuberances and depressions. On the chest, likewise, several protuberances were felt.

Over the region of the anterior mediastium, percussion revealed an area of dullness, reaching about an inch to right and left of the sternal margins.

Over the regions of the third, fourth, and fifth dorsal vertebræ, there was a protrusion and widening of the spine. A similar deformity was felt over the lower lumbar spine and sacrum. The right humerus contained many nodules over its surface as did the left, but to a lesser degree. Both femora presented bony irregularities, particularly in the upper portions.

The patient died on April 26, 1927, and no autopsy was obtained.

Diagnosis.—The clinical analysis of the case shows that the polypoid structure in the external ear, which appeared like exuberant neoplastic tissue, was apparently not the epidermoid cancer of skin with which the patient suffered three years ago, but was metastatic in nature. The dull area of the anterior chest began about one inch to the right and ended one inch to the left of the sternum. In the upper margin it began at the tip of the sternum and went down for two inches. The position of the dullness showed definitely that the tumor mass was situated neither in the mediastinum nor in the lungs, but in the intrathoracic part of the neck, and consequently represented a *carcinoma of an intrathoracic thyroid, with multiple osteoporotic metastases in the skeleton.* The neurologic condition was secondary to metastatic carcinoma of the vertebræ (paraplegia dolorosa Charcot).

Case 2. *Clinical History.*—A. K., white male, aged 73 years, who in September, 1928, developed an acute swelling in and

around the left sternoclavicular junction. A few days later, a similar swelling developed on the other side, and both swellings disappeared in a short time without treatment. A few days later, another swelling appeared in what seemed to be the region of the right lobe of the thyroid. Later, a similar condition appeared on the other side. All the swellings disappeared in a short time. In May, 1929, the patient began to suffer from constant pain in the front and back of his chest, accompanied by coughing and bloody expectoration and also by a high temperature. This acute condition subsided in about ten days. During this period, swellings appeared in the cervical region. About four weeks before examination, the patient suddenly felt a pressure pain in the back region immediately below the angle of the scapula. This pain has continued up to the present time. Occasionally, it comes in spasms, with comparative comfort between attacks. At present, the greatest pain he has had is in a recumbent position. The patient has not suffered from constipation, had normal bladder function, and a fair appetite.

Physical Examination.—The patient was emaciated, showing evidence of cachexia, and had the appearance of severe tension. In the right supraclavicular region a few lymph nodes were palpated. There was a very firm lynph node 2.5 cm. in diameter noted in the region of the mastoid. Another was palpated above the sternocleidomastoid region; it measured 4 cm. in diameter, was hard and nodular, and firmly attached to the underlying structure. There were other lymph nodes noted in both axillæ, being larger in the left. There were some small inguinal lymph nodes, more on the right side. No other abnormalities were noted.

Results of an x-ray examination of the chest and skeleton showed the following: There was an osteoporosis and decalcification observed in the ribs, spine, pelvis, and upper ends of the femora. In addition, there appeared an irregular, destructive process in the superior surface of the second lumbar vertebra with a definite upward concavity.

In the right lung there was noted an irregular infiltrative and fibrotic involvement, especially in the upper lobe, with some bronchiectatic and interstitial pneumonic changes appearing at the right base. Interlobar plastic pleurisy appeared at the level of the fourth rib, anteriorly. In the left side, the lung showed a similar infiltrative change in the upper lobe. In addition, at the level of the third rib, there appeared a small circular shadow of increased density measuring about 1 cm in diameter. A similar nodule, about 2.5 cm. in diameter, was noted at the level of the sixth rib, anteriorly.

Diagnosis.—Polyadenitis, noted in this case, with a history of swelling in the neck, appearing and disappearing without treatment, is a symptom-complex which would indicate that we were dealing with lymphoma malignum (Hodgkin's disease). The two discrete metastatic nodules noted in the x-ray examination may also have been lymphomatous nodules, but the multiple conditions in the skeleton did not coincide with Hodgkin's disease, and a biopsy of the nodule, which was situated in the right lobe of the thyroid microscopically, showed it to be a papillary adenocarcinoma of the thyroid.

In view of the pathologic findings, the conclusion was reached that the symptom-complex, particularly the severe pain in the back which was the major complaint of the patient, was due to the carcinoma of the second lumbar vertebra, secondary to papillary adenocarcinoma of the thyroid.

Case 3. *Clinical History.*—White female, aged 38 years, was admitted to the clinic in February, 1927, complaining of pain in the lower part of the back, which radiated mainly to the left thigh. The pain had continued for four months. The patient also complained of irregular menstruation which had continued for the last three years. She was referred to the clinic after a diagnosis of carcinoma of the cervix had been made elsewhere.

Physical Examination.—The patient ap-

peared to be well nourished. No adenopathy was noted. The thyroid appeared enlarged but was seemingly encapsulated and freely movable throughout. Examination of the pelvic organs showed no malignancy in the genito-urinary tract.

X-ray analysis showed an area of irregular rarefaction on the left side of the sacrum, involving the first and second sacral segments. The neurologic examination seemed to point to a tumor in the lower spine. Subsequent examination of the pelvic bones showed that rarefaction was gradually increasing in extent.

Diagnosis.—The problem to be solved was whether the rarefaction shown by the x-rays was due to a primary sarcoma of the sacrum or to a metastatic carcinoma with primary seat located elsewhere. It seemed rather unusual for sarcoma of the sacrum to continue for so many months, or for a tumor mass to grow out of the shell of the sacrum and produce a palpable mass.

Examination showed no malignancy anywhere. The only pathologic condition encountered was a small, freely movable goiter. Since this goiter might be the seat of malignancy and, if so, would cause an additional severe symptom-complex if allowed to develop further, a partial thyroidectomy was done and a microscopic examination showed an adenocarcinoma of the thyroid.

Subsequently, in an attempt to arrest the rapid growth of the sacral tumor and also in order to control pain, a partial excision, with insertion of radium, was done. Microscopic analysis of the tissue removed showed the identical picture of the thyroid carcinoma. The condition grew worse, notwithstanding all therapy, and the patient died.

In all three cases described above, the clinical symptom-complex as well as the evident pathology was caused by tumors in the bone, while the primary tumor in the thyroid was insignificant, both pathologically and clinically, compared with the condition in the skeleton. As a result in all three cases, the primary condition was overlooked.

Whenever a diagnosis of malignant tumor in the skeleton is made, single or multiple, a search must be undertaken for a primary malignant tumor elsewhere before the diagnosis of a primary malignant tumor in the skeleton can be made.

In a search for a primary malignant tumor, in a female, next to the breast, the thyroid must be thought of, and in a male, next to the prostate, the thyroid must be considered as the most probable seat. Such a diagnostic analysis is of importance not only from the theoretical but also from the practical clinical standpoint.

Metastases in the lungs and other regions do not present any diagnostic difficulties, since they appear when the local condition is far advanced.

THERAPY IN CARCINOMA OF THE THYROID

In view of the pathogenesis and mode of formation of carcinoma of the thyroid described above, the therapy in the early stage of the disease is, in reality, the therapy of benign goiter. Every goiter should be removed surgically in the usual manner as early as possible and the removed organ thoroughly examined microscopically. If evidence is found of proliferative activity, then the surgical removal should be followed by a course of radiotherapy over the operative field and also over the regions of the skeleton in which the skeletal metastases usually develop. This method of post-operative radiotherapy is identical with the one which the writer has been advocating for the last twenty years in early carcinoma of the breast.

Notwithstanding the excellent results obtained by the Coutard method of x-ray therapy in carcinoma of the mouth and neck, the writer is of the opinion that whenever an adequate amount of radium is available, radium therapy is the method of choice in these regions. In post-operative radiotherapy of carcinoma of the thyroid, the writer employs radium in the operative field and high voltage x-ray therapy over the chest and skeleton. When the condition is in an advanced stage and a hard nodular tumor is present,

invading diffusely the thyroid and firmly adherent to the underlying tissues of the neck, then any attempt at surgical removal of the tumor is useless and the treatment of choice is radiotherapy.

The method used by the writer consists in an incision over the tumor, a biopsy, and, depending upon the size of the tumor, either buried gold seeds or the insertion of removable platinum needles. The writer has devised a special platinum needle which opens on both sides and allows the introduction of a glass capillary of radon.

In radiotherapy of exophthalmic goiter, the aim is to reduce the hyperfunction of the thyroid and bring it to norm, and care must be taken not to create hypofunction of the gland.

In carcinoma of the thyroid, the objective is to destroy all the carcinomatous tissue, which must be accompanied by the destruction of the remnants of the normal thyroid tissue. As a result, there always develops a certain degree of myxedema. This complication is not only unavoidable but desirable, since it proves that a good therapeutic result was obtained. It has been amply proven that carcinoma of the thyroid functions in the same manner as a normal gland. Whenever such a myxedema disappears without treatment, it is an indication of either local recurrence or metastases formation.

The following case clearly illustrates these points.

Case 4. *Clinical History.*—A. G., white female, aged 39 years, was admitted to the hospital in February, 1935, complaining of a paroxysmal dry cough, particularly after deglutition of fluids, and pain in the area of a recent scar on the neck. The patient had been operated upon three months previously in the region of the thyroid gland, and a diagnosis of malignancy was made in the hospital.

Physical Examination.—The patient is fairly well nourished but anemic and not cachectic. Across the neck about four cm. above the clavicle, there is noted the curved scar of a recent operation. Immediately above the scar and parallel to it there is palpated an oblong tumor mass, stony hard and nodular. This mass is about four cm. long, two cm. wide, and one cm. in thickness. It replaces the *right lateral lobe and the isthmus* of the thyroid gland. The left lobe is very small and normal in consistency. The tumor mass is freely movable over the skin but is firmly adherent to the underlying tissues. There is no adenopathy noted. There are no masses in the abdomen, and no clinical evidence of metastases in the skeleton.

X-ray examination of the chest and skeleton shows no metastatic tumors either in the lungs or in the skeleton.

Treatment.—An incision was made one cm. above and parallel to the scar, the skin and subcutaneous tissue being divided and the tumor mass exposed, with the fascia attached to and forming a part of the tumor. A biopsy was taken over the center of the tumor and four platinum needles containing 40 millicuries in all were inserted parallel to the incision and about one cm. apart from each other. The skin was closed over the needles, which were removed 60 hours later.

Microscopic analysis of the removed tissue showed an adenocarcinoma of the thyroid. The intratumoral insertion of radium was subsequently followed by high voltage and x-ray therapy over the chest and skeleton, and surface radium application to the neck.

Examination.—In May, 1935, there had been a complete disappearance of the tumor of the thyroid, and, to judge by palpatory evidence, also the disappearance of the normal left lobe. The patient complained of general asthenia and sluggishness, both in physical as well as mental activity. She had increased in weight from 129 pounds to 169 pounds, which was a serious overweight considering that her height was only 5 feet. The eyelids appeared puffy, the skin was somewhat dry, gray in color, and the speech was thick and slow. At the same time the patient complained of stiffness in the various joints.

Basal metabolism did not show any se-

vere decrease. Nonetheless, the patient gave the appearance of acute post-therapeutic myxodema.

X-ray examination of the chest and skeleton at this time again showed no evidence of any metastatic tumors anywhere.

The woman was given powdered thyroid, and the symptom-complex gradually improved to a certain extent but not completely.

Analysis of this case indicates that in a case in which surgery failed to remove the carcinoma of the thyroid, subsequently, radiotherapy succeeded in destroying completely the malignant tumor.

Normal thyroid tissue as well as carcinoma of the thyroid represents one of the most radiosensitive tissues of the organism, and it is undoubtedly possible to keep patients suffering from carcinoma of the thyroid under control by the aid of radiotherapy.

SUMMARY

Carcinoma of the thyroid represents only a phase in the development of goiter. A functional enlargement of the thyroid, a benign neoplasia, and a carcinoma may very imperceptibly pass from one to another.

A microscopic diagnosis of carcinoma of the thyroid is extremely difficult, and, when a clinical diagnosis is possible, the condition is in a far advanced stage of the disease. The incidence of carcinoma of the thyroid is much more frequent than the clinical statistics indicate.

Metastases, particularly in the skeleton, frequently appear much sooner than the local evidence of malignancy, and presumably develop even secondary to a benign goiter, though, in the opinion of the writer, a small region of carcinoma was overlooked in all these cases.

Three cases are reported of skeletal metastases secondary to carcinoma of the thyroid, in which the clinical symptom-complex as well as the evident pathology was caused by tumors in the bone. Both pathologically and clinically, the primary tumor in the thyroid was insignificant as compared with the condition in the skeleton, and as a result the primary condition was overlooked.

A diagnosis of primary malignant tumor in the skeleton should not be reached until after a search has been made for another primary, and this search must include the thyroid.

Surgical therapy in carcinoma of the thyroid is of value only before the local or distant clinical evidence of malignancy appears. When a thyroid tumor becomes adherent to the surrounding tissues the surgical removal is useless.

Radiotherapy in carcinoma of the thyroid, if successful, may be followed by myxedema.

Radiotherapy in carcinoma of the thyroid should not be limited to the region of the thyroid but should also include the regions in which metastases may occur. This method is similar to the one which the writer has been advocating in carcinoma of the breast for the last twenty years.

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THE SHAPE OF THE FEMALE PELVIS AND ITS CLINICAL SIGNIFICANCE: A ROENTGEN AND CLINICAL STUDY[1]

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"Thou com'st in such a questionable shape
That I will speak to thee."—*Hamlet, I, 4.*

THAT the shape of the normal pelvis may vary considerably in different persons is well known to all of us. That this shape exerts a significant influence on the course of labor has been suspected by some of us—an influence which is not indicated by classical measurements, even when these are well within the normal range. Two years ago, Caldwell and Moloy (1) came to the conclusion that normal female pelves could be classified into four main groups, depending upon their shape as determined by roentgen examination. In addition to this classification into different groups or types, they stressed the importance of qualifying features, principally the general size of the pelvic inlet and the width of the subpubic arch. This work seemed to us of considerable interest, not only as a simple method of classifying pelves, but also as a potential aid in forecasting the course of labor.

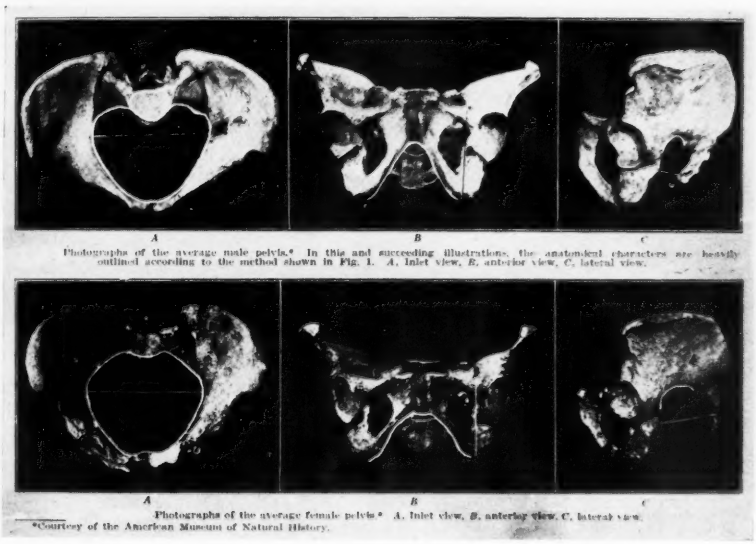
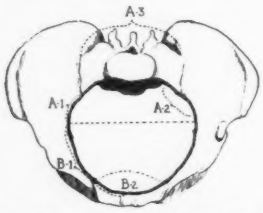

A
B
C
Photographs of the average male pelvis.* In this and succeeding illustrations, the anatomical characters are heavily outlined according to the method shown in Fig. 1. A, Inlet view, B, anterior view, C, lateral view.
A
B
C
Photographs of the average female pelvis.* A, Inlet view, B, anterior view, C, lateral view.
*Courtesy of the American Museum of Natural History.

Fig. 1. Photographs of typical male and female pelves (after Caldwell and Moloy). The morphologic features significant in pelviography have been outlined (the pelvic inlet, the subpubic angle, and the greater sciatic notch).

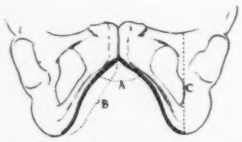
Accordingly, we made roentgen examinations of 100 consecutive primigravidæ from the obstetrical clinic of the San Francisco Hospital (wherein they were all delivered), classified their pelves according to the method of Caldwell and Moloy, and then correlated this classification with the observed course of labor. In addition, we studied a small group of cases of known

[1]Read by title before the Radiological Society of North America, at the Twenty-first Annual Meeting, in Detroit, Dec. 2–6, 1935.

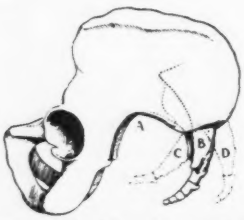
dystocia in which ordinary manual pelvimetry had failed to forecast events as they actually occurred. This group was selected because the incidence of dystocia in the unselected group of 100 primigravidæ was very low (approximately 17 per cent), and we wished to ascertain the type of pelvis occurring in cases in which the obstetrician is seriously in need of more help than ordinary clinical pelvimetry furnishes.



A diagrammatic representation of the anatomical variations at the inlet with definition of terms. *A*, The "posterioriliac portion" of the inlet. Variable in length and curvature. *A*, The sacrosciatic notch. Variable in size and shape. *A*, The sacrum. Variable in size, shape, and inclination. *B*, The "anterior pubo iliac" portion of the inlet. Variable in length and curvature. *B*, The angle between the pubeiliac portions of the fore pelvis. Variable in size.



A diagrammatic study of the variations which materially affect the fore pelvis. *A*, The subpubic angle. Variable in size. *B*, The length, curvature, and mode of origin of the pubic rami from the body of the pubic bone. *C*, The depth of the true pelvis.



A diagrammatic study of the variations which affect posterior pelvis capacity. *A*, The size and shape of the sacrosciatic notch. *B*, Sacrum with normal curvature and inclination. *C*, Acute forward curvature in the terminal segments. *D*, A straight sacrum.

Fig. 2. Diagrammatic representation of the anatomical features significant in pelviography (from Caldwell and Moloy). The term "greater sciatic notch" is preferred to "sacrosciatic notch."

ROENTGEN TECHNIC

The classification of female pelves used in this study depends chiefly upon the following factors:

(1) The shape and size of the pelvic inlet; (2) the shape and size of the subpubic angle; (3) the shape and size of the greater sciatic notch in the lateral projection.

Additional factors were also studied, and were of some influence in classification, but the main consideration in technic was to reproduce as accurately as possible the above-mentioned three anatomic features in the roentgenograms. It is to be remembered that the present study is limited to the classification of pelves on the general basis of shape alone (pelviography), rather than on the basis of accurate mensuration (pelvimetry). Since the shape of the pelvis can be studied accurately by plain films, stereoscopic roentgenograms were intentionally dispensed with in this series. Needless to say, for the complete roentgen study of the female pelvis both methods are essential; for the study of the gravid female near term, fetal cephalometry is advisable as well.

(*1*) *Pelvic Inlet.*—An anteroposterior projection of the pelvis is made, with the patient in the supine position, and an ordinary well-stuffed pillow under the patient's lumbar region; the x-ray tube is tipped ten degrees caudad. The importance of this angle is stressed, since the

CHARACTERISTICS OF THE CLASSICAL MALE AND FEMALE PELVIS
(AFTER CALDWELL AND MOLOY)

	GENERAL OUTLINE	ANTERIOR SEGMENT	POSTERIOR SEGMENT	SUBPUBIC ANGLE & ALLIED FEATURES	GREATER SCIATIC NOTCH	ISCHIAL SPINE	INCLINATION OF SACRUM	CURVATURE OF SACRUM
MALE	Triangular or "blunt-heart shape" Widest transverse diameter lies in posterior one third of inlet	Narrow retropubic angle	Short, straight posterior iliac sections	Narrow, subpubic angle. Pubic rami straight. "Depth" of true pelvis long average 101 mm.	Narrow and long	Prominent and sharp	Vertical or ventral	Variable or shallow
FEMALE	Round Widest transverse diameter lies in middle one-third of the inlet	Broad retropubic angle	Long, curved posterior iliac sections	Wide subpubic angle. Pubic rami curved and with "rolled edges". "Depth" of true pelvis short, average 90 mm.	Wide and shallow	Moderately prominent	Dorsal	Deep

Table I

apparent shape of the inlet can be distorted by its omission. This is well illustrated in Figure 11.

DIFFERENTIAL FEATURES OF THE VARIOUS TYPES OF FEMALE PELVIS*
(AFTER CALDWELL AND MOLOY)

TYPE	PELVIC INLET			SUB-PUBIC ANGLE	GREATER SCIATIC NOTCH	ISCHIAL SPINE	INCLINATION OF SACRUM	CURVATURE OF SACRUM
	GENERAL OUTLINE	ANTERIOR SEGMENT	POSTERIOR SEGMENT					
GYNECOID	"Round" shape	Broad with wide retropubic angle	Long, curved posterior iliac section	Average to wide	Wide	Average	Dorsal Variable	Deep Variable
ANDROID	Blunt heart shape	Narrow with narrow retropubic angle	Short fairly straight posterior iliac sections	Average to narrow	Narrow and long	Sharp	Ventral Variable	Shallow Variable
ANTHROPOID	Sagittal or anteroposterior ellipse	Average or narrow with variable retropubic angle	Long, curved posterior iliac sections	Average to wide	Very wide and shallow	Blunt	Variable	Variable
PLATYPELLOID	Transverse "ellipse"	Broad with very wide retropubic angle	Long, posterior iliac sections	Variable	Narrow variable	Variable	Variable	Variable
ASYMMETRIC	Variable	Frequently straight puboiliac section on one side	Frequently short posterior iliac section on one side	Variable	Narrow on the same side as the short posterior iliac section	Variable	Variable	Variable
MIXED	Variable	A posterior segment of one type is associated with an anterior segment of another		Variable	Variable	Variable	Variable	Variable

* Based on the shape of the pelvis. Further division must also be made according to the size of the inlet: large, medium and small.

Table II

(2) *Subpubic Angle.*—With the patient still in the supine position, the lumbar pillow is removed and the tube tipped 30 degrees cephalad; the tube is centered just below the symphysis, and an oblique projection of the pubic arch is made. Caldwell and Moloy state that an angle of 45 degrees is used; we have found that this is impractical. In fact, at the time of writing, we are making a study of different methods of projecting this angle, and believe that a different technic may well be adopted in the future.

(3) *Greater Sciatic Notch.*[2]—A lateral film of the pelvis is made, padding the patient's lower costal area to make the axis of the sacrum as nearly parallel to the table as possible. An attempt is made to secure superimposition of the shadows of both greater sciatic notches.

The actual technical factors for a patient of average size are:

Position	*K.v.p.*	*Ma.*	*Dist.*	*Time*	*Film*
A. P. Pelvic Inlet (10°)	66	15	36	8	11x14
A. P. Subpubic Angle (30°)	66	15	36	9	8x10
Lateral Pelvis	66	10	36	40	11x14

It is important to use a small or medium-sized cone, and a Potter-Bucky diaphragm, spending considerable time posing the patient, especially for the lateral projection. Slight rotation causes an asymmetric appearance. We believe it is valuable to use a uniform distance for all projections.

ROENTGEN INTERPRETATION

It is necessary to survey a group of roentgenograms of female pelves at one sitting in order that we may become familiar with the variations upon which the differential diagnosis of "pelviograms" is based. The differential features of the

[2] *Terminology.* We have followed the terminology outlined by Dr. Caldwell and Dr. Moloy with but one exception. Both from their illustrations and their text, we believe these authors mean the *greater sciatic notch* when discussing the sacrosciatic notch in the lateral roentgenograms. We believe it important to use the term *greater sciatic notch,* since the width of this notch is quite independent of the inclination of the sacrum; that is to say, one may have a very narrow sacrosciatic space with a very wide notch in a patient with a ventrally inclined sacrum. The use of the term "sacrosciatic" is confusing.

To simplify the terminology of Dr. Caldwell and Dr. Moloy, we have termed the posterior iliac section of the pelvic inlet as the *posterior segment,* and the anterior puboiliac section as the *anterior segment.* Similarly, the angle made by the anterior puboiliac portions has been termed the *retropubic angle* for purposes of brevity.

There are valid objections, philologic and otherwise, to the use of the terms *gynecoid, android,* and *anthropoid* in connection with this work. These are dealt with by the authors referred to; we know of no better terms at present.

classical female and male pelvis are illustrated in Figure 1 and outlined in Table I. The differential features of the various gave most significance in classification were the shape of the *posterior segment* of the pelvic inlet, the shape of the *anterior segment* of the pelvic inlet, and the shape of the greater *sciatic notch* (Fig. 2); the subpubic angle is not used in classification (but is used in prediction). Sometimes an extreme type of sciatic notch influenced us in modifying the type of pelvis as much as the shape of the anterior segment. For example, a gynecoid type of posterior segment with a doubtfully android anterior

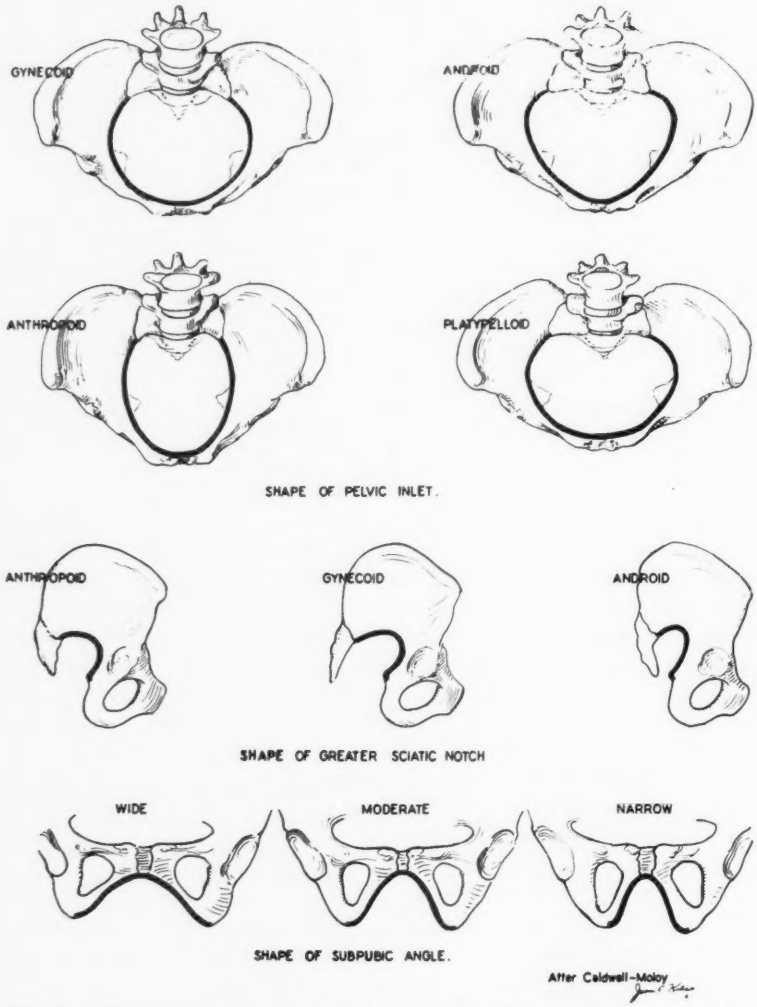


Fig. 3. Diagrammatic representation of the significant anatomical features of the four main types of female pelves.

morphologic types of female pelvis are illustrated in Figure 3 and outlined in Table II. The actual method used in interpreting individual pelves was to note each feature as outlined in the heading of Table II, and then to summarize our opinion as to the type of pelvis, the approximate size of the inlet, and the size of the subpubic angle. The factors to which we

RELATIVE INCIDENCE OF VARIOUS TYPES OF PELVES

(COMPARISON OF AUTHORS' WITH CALDWELL AND MOLOY'S SERIES *)

TYPE OF PELVIS	AUTHOR'S SERIES LIVING ROENTGEN STUDIES 100 UNSELECTED PRIMIPARA	CALDWELL-MOLOY SKELETAL STUDIES 147 DRIED FEMALE PELVES
GYNECOID	51.0%	41.4%
ANDROID	21.0%	32.5%
ANTHROPOID	18.0%	23.5%
PLATYPELLOID	5.0%	22.6%
ASYMMETRICAL	5.0%	——

* PELVES WITH MIXED TENDENCIES WERE GROUPED WITH THE PARENT TYPE IN ALL THESE TABLES.

Table III

segment and a definitely android (narrow) sciatic notch would be classified as a gynecoid type with android tendency, or, in brief, a gynecoid-android type.

Pelvic Inlet.—In examining the pelvic inlet, if one fails to use the lumbar pillow or the 10° angle caudad, one will secure a film in which the obturator foramina are more or less well seen, and one may easily interpret the pelvis as having a platypelloid tendency. On the other hand, if one uses a 20° angle caudad, or an extremely thick lumbar pillow, one may secure an artificially anthropoid appearance of the inlet (Fig. 11). Since individual female lumbosacral angles vary a little, one cannot make any hard and fast rule for the successful reproduction of the inlet; careful study of the accompanying illustrations will give one an idea as to what one should obtain. In perhaps 15 per cent of cases, one will have to retake the film, using an angulation caudad of more than ten degrees.

Having estimated the shape or type of the pelvic inlet, one should estimate its approximate size (small, average, or large). Since Caldwell and Moloy judged the size without measuring, we have taken the liberty of doing likewise. All of our films were made at a uniform target-film distance (36 inches), and all our estimations were made at one of three sittings, at which groups of 35 or more pelves were reviewed at one time. Hence, we believe that our estimates are reasonably accurate.

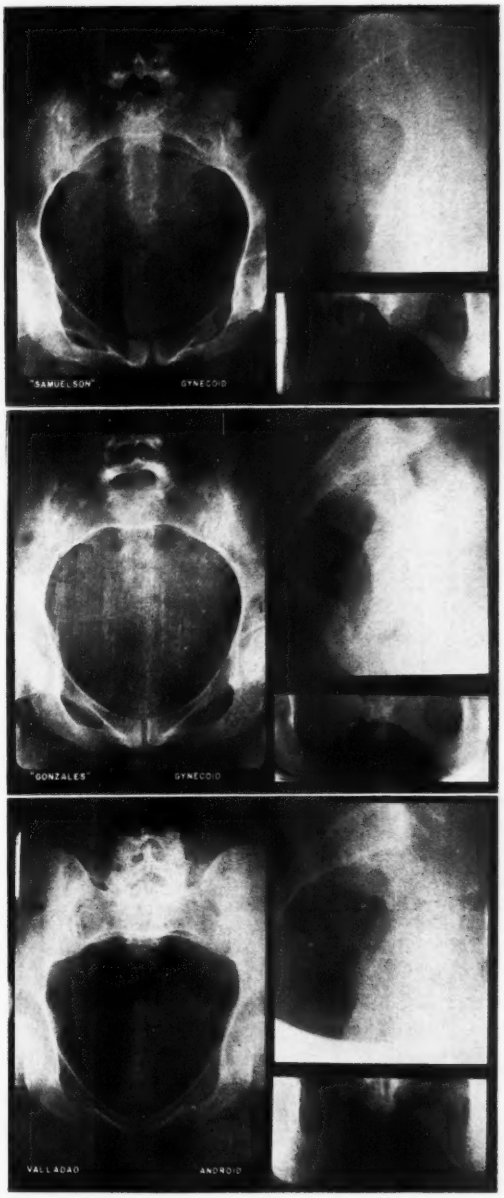


Fig. 4 (*top*). Gynecoid type of pelvis with large inlet and wide subpubic angle.
Fig. 5 (*center*). Gynecoid type of pelvis with average inlet and wide subpubic angle.
Fig. 6 (*bottom*). Android type of pelvis with average inlet and moderate subpubic angle.

Furthermore, we rechecked the first ten cases after surveying one-half of the material and found we had changed our opin-

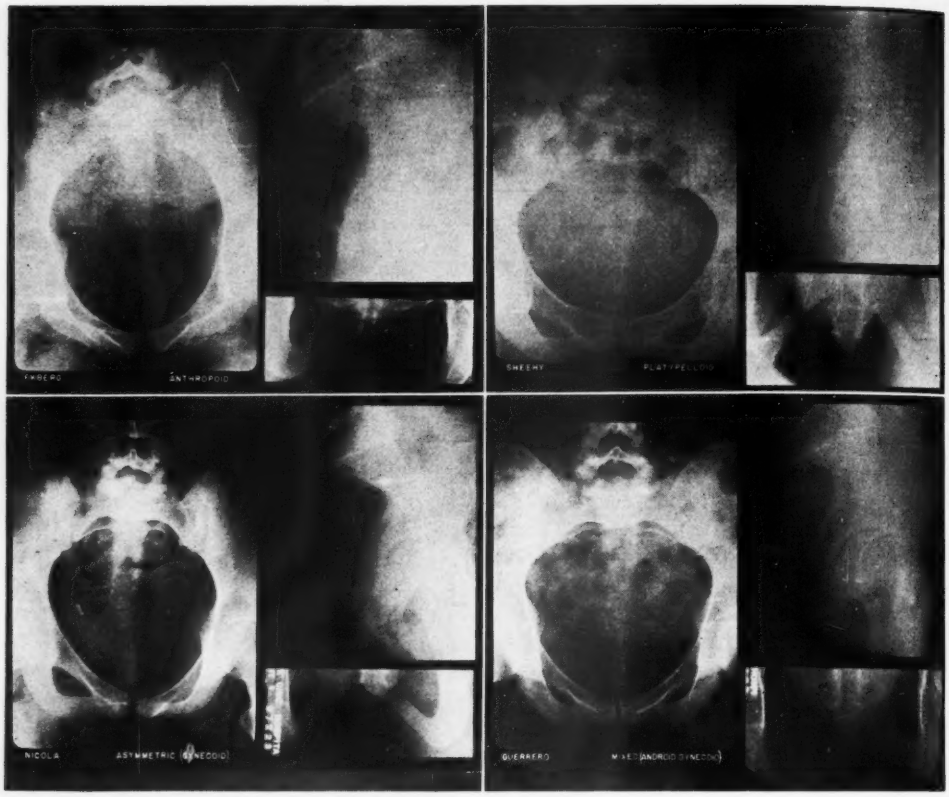


Fig. 7 (*upper left*). Anthropoid type of pelvis with average inlet and wide subpubic angle.
Fig. 8 (*upper right*). Platypelloid (flat) type of pelvis with average inlet and narrow subpubic angle.
Fig. 9 (*lower left*). Asymmetric gynecoid type of pelvis with average inlet and moderate subpubic angle.
Fig. 10 (*lower right*). Mixed type (android-gynecoid) pelvis, with average inlet and moderate subpubic angle.

ion as to the size of inlet in only one case. However, in estimating the size of individual pelves, we believe that actual measurements should be employed, for example, the sagittal and the transverse diameters of the inlet. We shall publish such figures in our next paper. We have recently learned that Dr. Caldwell and Dr. Moloy now measure pelves routinely.

Subpubic Angle.—The width of the subpubic angle has been estimated but not actually measured in this series. It is our intention in the future to measure this angle in a manner similar to that used for measuring the degree of the sacral inclination (Fig. 12).

Greater Sciatic Notch and Other Features.—Good lateral roentgenograms of stout patients are sometimes difficult to secure. Very thin females with very broad hips tend to become slightly rotated on the average Bucky table, so that one does not secure superimposition of the greater sciatic notches in the roentgenogram. The attempt should be made to find the notch nearest to the film and, since this will show the least distortion, to decide whether this is "obtuse" (anthropoid), "acute" (android), or "moderate" (gynecoid) (Fig. 3). We believe that a more scientific method of measuring the shape and size of this notch must be evolved before it can really be allowed significantly to influence the classification of pelves; we are studying this phase of the problem at the present time.

The shape and size of the ischial spine should be helpful in classifying pelves,

since it has been shown that, in lateral views of android pelves, it appears sharp and pointed, in anthropoid pelves it appears blunt and shallow, and in gynecoid pelves it appears of moderate size. However, in actual practice, one finds that the spine is often obscured by collections of fecal matter or gas in the rectum, or that slight rotation of the pelvis prevents ones estimating its exact shape. With improving technic, however, this point should be of value.

The inclination of the sacrum and the depth of the sacral curve varies in different types of pelves. A ventrally inclined, straight sacrum often occurs in android types; a vertically inclined, curved sacrum in anthropoid pelves, and a dorsally inclined, curved sacrum in gynecoid pelves. In actual practice one finds it extremely difficult to estimate either the inclination of the sacrum or its depth of curvature. Since the lower lumbar spine did not show in most of our films, we attempted to measure the inclination of the sacrum in relation to the plane of the pelvic inlet, as

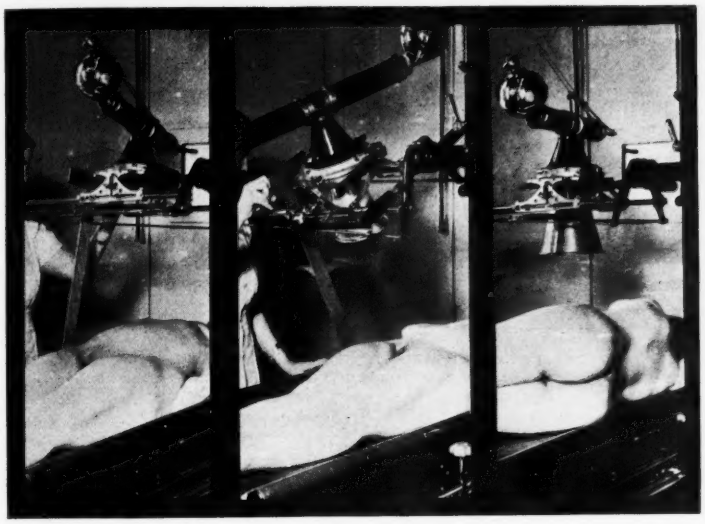


Fig. 11. Illustrations showing the influence of technic on the appearance of the pelvic inlet. All illustrations are of the same patient. The first is made with no lumbar pillow and no angulation of the tube. The second is made with a lumbar pillow but no angulation of the tube. The third (and correct projection) is made with a lumbar pillow and an angulation caudad of 10 degrees. Note that the obturator foramina are not visible in the correct projection, and that from an apparently android inlet one changes to a gynecoid-anthropoid one.

INCIDENCE OF VARIOUS TYPES OF PELVES WITH THEIR SUB-GROUPS
(AUTHOR'S SERIES OF 100 UNSELECTED PRIMIGRAVIDAE)

ANDROID GROUP		ANTHROPOID GROUP		GYNECOID GROUP		PLATYPELLOID GROUP		ASYMMETRIC GROUP	
ANDROID	5	ANTHROPOID	14	GYNECOID	42	PLATYPELLOID	3	AS ANDROID	0
AND ANTHROPOID	2	ANTH ANDROID	0	GYN ANDROID	2	PLAT ANDROID	0	AS ANTHROPOID	3
AND GYNECOID	14	ANTH GYNECOID	4	GYN ANTHROPOID	7	PLAT ANTHROPOID	0	AS GYNECOID	2
AND PLATYPELLOID	0	ANTH PLATYPELLOID	0	GYN PLATYPELLOID	0	PLAT GYNECOID	2	AS PLATYPELLOID	0
TOTALS	21		18		51		5		5

Table IV

illustrated in Figure 12. The results of these measurements are outlined in Table IX. The value of this factor in influencing the classification of the pelvis is probably slight. It is to be noted that the points used are (*a*) the promontory or upper, anterior margin of the first piece of the sacrum, (*b*) the mid-point of the upper edge of the symphysis pubis, and (*c*) the lower, anterior edge of the last piece of the sacrum (or the last fixed piece of the sacrococcygeal area in patients with assimilation of the first coccygeal segment). It is often difficult to decide point "*c*." The concave curvature of the sacrum was determined by measuring the maximum depth between the ventral surface of the sacrum and a line joining points "*a*" and "*c*."

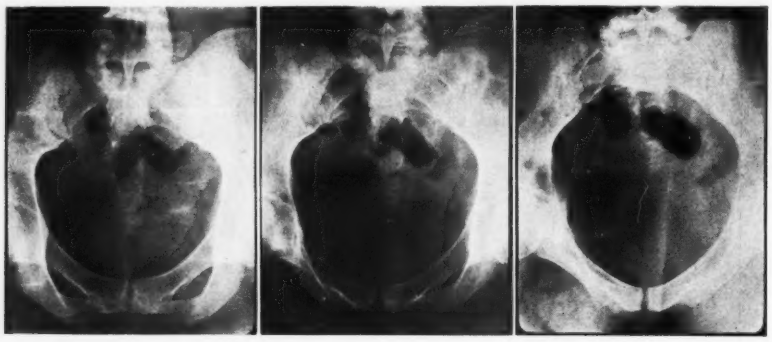


Fig. 12. Illustration of the methods used to measure the *inclination* of the sacrum (relative to the plane of the pelvic inlet) and the depth of *curvature* of the sacrum.

DISCUSSION OF ROENTGEN FINDINGS

Many pelves (35 per cent in this series) will not fall into one of the four main types as described by Caldwell and Moloy in their first paper. In this event, one still bases one's classification on the shape and size of the posterior segment of the pelvic inlet, and modifies that classification by the most prominent other features present, usually the anterior segment of the inlet or the greater sciatic notch. For example, an anthropoid type of posterior segment with a typically android anterior segment or notch will be classified as an anthropoid type with android tendency (anthropoid-android type).

For clinical purposes it is not sufficient to classify a given female pelvis as android or gynecoid, etc. One must mention the following three features: (*a*) the general type of the pelvis; (*b*) the size of the inlet; (*c*) the size of the subpubic angle. For example, the pelvis illustrated in Figure 6 is an android type of pelvis, of average size and with a moderate subpubic angle.

INFLUENCE OF THE TYPE OF PELVIS (INCLUDING SIZE OF THE SUBPUBIC ANGLE) ON THE DURATION OF LABOR

TYPE OF PELVIS	DURATION OF LABOR (HOURS) FIRST AND SECOND STAGES				Average weight of child (pounds)
	Average or wide subpubic angle	Narrow subpubic angle	ENTIRE GROUP	PURE TYPES	
GYNECOID	15.3	15.2	15.5	15	7.5
ANDROID	17.0	21.3	19.0	20	7.2
ANTHROPOID	15.5	—	15.5	15	7.5
PLATYPELLOID	12.0	—	12.0	13	7.0
ASYMMETRIC	12.0	—	12.0	—	7.0

Table V

INFLUENCE ON THE TYPE OF PELVIS ON THE NECESSITY FOR SURGICAL INTERVENTION

TYPE OF PELVIS	PERCENTAGE OF CASES REQUIRING OPERATIONS FOR DYSTOCIA	
	PURE & MIXED TYPES ALL CASES	PURE TYPES
GYNECOID	11.7%	12.8%
ANDROID	29.0%	40.0%
ANTHROPOID	22.0%	28.6%
PLATYPELLOID	20.0%	33.3%

Table VI

DISCUSSION OF CLINICAL FINDINGS

In the present series of 100 unselected primigravidæ, the relative incidence of the various types of pelves as determined roentgenographically compares fairly closely with that of Caldwell and Moloy in their studies of skeletal material (Table III).

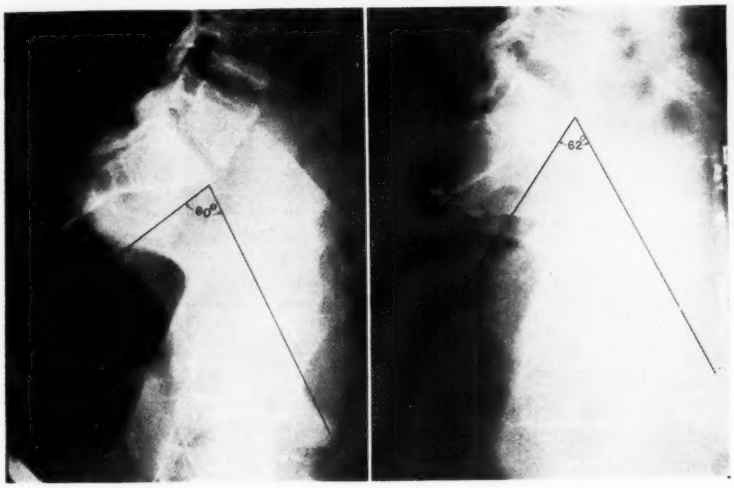


Fig. 13.

In Table IV are shown the various subgroups into which the four parent groups have been divided in our series. This is in accord with the second publication of Caldwell and Moloy, and we feel that the increased complexity of the classification is thoroughly justified and necessary for purposes of greater accuracy in description and for use in clinical correlation.

The influence of the type of pelvis on the duration of labor is significant (Table V). When the entire group is studied it is found that the average duration of labor in women with gynecoid pelves is 15.5 hours, and in women with android pelves, 19 hours. When women with "pure" gynecoid or "pure" android pelves are studied (that is, when mixed types are discarded), the difference becomes even more significant, the average labor in gynecoids being 15 hours and in androids 20 hours. It should be noted that the number of patients in the platypelloid group is really too small to permit one to arrive at significant figures, and, therefore, the average of 13 hours shown in Table V should probably be disregarded. Many other factors, such as the general size of the pelvis, the size of the baby and so forth, have influenced the relatively short labor in our small series of platypelloids to date.

We now come to the most interesting part of our clinical work, namely, the correlation of the type of pelvis with the necessity for surgical intervention (under which we include both Cesarean and forceps cases in the present paper). In Table VI it will be seen that the necessity for surgical intervention was not appreciably different in the "pure" gynecoid as contrasted with the entire gynecoid group. However, in the android, the anthropoid, and the platypelloid groups it will be seen that the necessity for operative interference was markedly increased in the "pure" types. The reason for the difference in the labors of the entire group and that of the "pure" group is that the former contains sufficient modifying tendencies to offset the unfavorable predominant anatomic features in the latter. For example, a definitely android pelvis has a significant chance of requiring surgical intervention (40 per cent in our series), but an android-gynecoid or an android-anthropoid pelvis

TYPE OF PELVIS FOUND IN CASES OF KNOWN DIFFICULT LABORS
(14 SELECTED CASES)

TYPE OF PELVIS	NUMBER OF CASES	PERCENTAGE
GYNECOID	7	50%
ANDROID	4	28%
ANTHROPOID	1	7%
PLATYPELLOID	1	7%
ASYMMETRIC	1	7%

Table VII

may have a sufficiently wide inlet or sufficiently broad greater sciatic notch to so improve the shape of the outlet as to permit a relatively easy labor.

SPECIAL STUDY OF WOMEN WITH KNOWN DIFFICULT LABORS

To date, we have studied 14 patients selected on account of known difficult labor. The different types of pelves occurring in this group are summarized in Table VII; it is to be noted that both "pure" and "mixed" types are listed together in this table. The following is a detailed record of the various types seen:

Gynecoid.....4 cases
Gynecoid-android.....3 cases
Android.....2 cases
Android-gynecoid.....3 cases
Platypelloid.....1 case
Asymmetric android.....1 case

The similarity of the incidence of the various gynecoid types in this selected group as compared to that in the larger unselected series of primigravidæ is surprising. However, three out of the four "pure" gynecoid cases in the selected group had a *narrow* subpubic angle (75 per cent), while only seven in the unselected group had such (14 per cent). The presumptive reason for the high incidence of dystocia in the "selected" group of gynecoid cases is the presence of this narrow subpubic angle or of some other modifying

INCIDENCE OF NARROW SUBPUBIC ANGLE

UNSELECTED GROUP	(100 consecutive primigravidae)	14.0%
SELECTED GROUP	(14 with hard labors)	28.6%

Table VIII

AVERAGE "INCLINATION" OF SACRUM AND "DEPTH" OF SACRAL CURVE

TYPE OF PELVIS	INCLINATION OF SACRUM (degree)	DEPTH OF SACRAL CURVE (mm)
GYNECOID	69.9	27.7
ANDROID	75.8	28.5
ANTHROPOID	69.7	30.5
PLATYPELLOID	80.5	22.0
ASYMMETRIC	74.4	28.4

Table IX

feature, such as an android tendency, a small inlet and so forth.

Probably the most significant modifying feature is a narrow subpubic angle. In Table VIII the incidence of this narrow angle in the unselected group of 100 primigravidæ is contrasted with its incidence in the selected group of cases with dystocia, being more than *twice* as great in this latter group.

SUMMARY

The classification of female pelves into four main types, based on certain architectural or morphologic characteristics as described by Caldwell and Moloy, is outlined. In addition to these four main types there is a small number of asymmetric pelves, which can be classified under one of the above types.

The four main types are termed gynecoid, android, anthropoid, and platypelloid. In a group of 100 unselected primigravidæ, the incidence of these types was found to be as follows: gynecoid group, 51 per cent; android group, 21 per cent; anthropoid group, 18 per cent; platypelloid group, 5 per cent; asymmetric pelves, 5 per cent. The incidence of these types

in our series is compared with that reported by Caldwell and Moloy.

Of the entire group of 100 pelves, approximately 65 per cent constituted "pure" types and 35 per cent "mixed" types, that is to say, the latter had to be classified as android-gynecoid types, gynecoid-anthropoid types, etc.

The roentgen technic and methods of interpretation are outlined in detail. Roentgenograms of the various types of pelves are illustrated.

The obstetrical significance of the various types of pelves appears to be as follows:

(1) The necessity for operative intervention in the gynecoid types is low.

(2) The necessity for intervention in the android, anthropoid, and platypelloid groups is increased, especially in the pure types of these pelves, being as high as 40 per cent in the *android* types.

(3) A narrow subpubic angle is the most unfavorable single anatomic feature in producing difficult labors.

It is to be remembered that it is not sufficient to classify pelves on shape alone. One should note three features: the type of the pelvis, the size of the inlet, and the shape of the subpubic angle.

CONCLUSIONS

The classification of female pelves on an architectural basis by roentgen methods (pelviography) is a simple and clinically feasible procedure.

In a significant number of cases, a difficult labor can be forecast by pelviography in patients whose obstetrical measurements by ordinary methods appear normal. This is especially evident in the android group.

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VERTEBRAL INVOLVEMENT IN HODGKIN'S DISEASE

REPORT OF THREE CASES

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THE incidence of bone involvement in Hodgkin's disease is much higher than we have been led to believe by reports in the literature, and a more frequent complete radiologic investigation of the skeleton in cases suspected of Hodgkin's will, not infrequently, show osseous involvement, even though this may not be clinically suspected. Jenkinson states that in the study of his cases there was evident a similarity between bone metastases of carcinoma and bone changes in Hodgkin's disease. Reisner and Brada state that in their series of Hodgkin's cases, 74 per cent presented bone involvement, and in approximately 50 per cent of these, the lesions were situated in the spinal column. Bone involvement, however, is usually considered a late development in the course of the disease.

As in carcinoma, the vertebra, ribs, pelvis, and femora are most frequently the site of changes in Hodgkin's disease. Lockwood, Johnson, and Narr report a case of a boy, aged 15 years, in whom a roentgenogram revealed definite bone destruction in the first four lumbar vertebræ, the ilium, and the femora. The course was increasing bone destruction of the dorsal and lumbar vertebræ, with the involvement of all lymph nodes, lungs, liver, skeletal muscles, and skin. Friedrich reports a case of a boy, aged 20 years, in whom both jaws were involved, presenting numerous areas of rarefaction in the central portion of the jaw, and marked increase in the density of the marginal portion. Joly reports three cases of Hodgkin's disease with involvement of the bones, tibia, vertebræ, ribs, and femur.

How this disease spreads through the body is still a matter of speculation, and, as far as we know to-day, Hodgkin's disease starts in the lymphatics, and, for a long time, remains confined to them. However, because of the large number of distant bone metastases, we believe there is sufficient proof of the theory that this disease may spread *via* the blood stream, as well as the lymphatics.

The changes occurring in bone are of two types, osteoblastic and osteoclastic. The causative agent is, as yet, unknown, and a specific organism has not been identified. Patients are presumably sensitized in such a fashion that their reticulo-lymphatic apparatus and bone marrow will react in a specific manner. Locally, there is produced the characteristic polymorphocellular granulation tissue that invades adjacent vital structures by direct extension. This arouses non-specific inflammatory reactions, producing secondary local mechanical damage, invasion of the epidural space through the intervertebral foramina, or involvement of the bodies of vertebræ, with or without a collapse of the latter.

In the x-ray film, Hodgkin's disease of bone takes the form of periostitis, with marked periosteal proliferation and thickening of the cortex of diffuse destruction with collapse, as seen in the case of diseased vertebræ. Sometimes a combination of bone destruction and an attempt of bone repair is seen.

Treatment in Hodgkin's disease is best carried out by x-ray therapy, and good results are reported by Minot, Jenkinson, Lockwood, Kaplan, and others. Radiation affects both glandular and bony tissues directly, and also acts as an analgesic, especially in cases in which bone lesions are present. Osteolytic destruction may be stimulated by x-rays, and the cavity is refilled by new bone. In many instances invasion of the skin is a prominent feature,

Fig. 1. Case 1.

Fig. 2. Case 2.

and often is the chief complaint. This was so in Lockwood's case, reported above.

Three cases of Hodgkin's disease involving the spine are herewith reported.

Case 1. M. A., a white girl, aged 17 years, entered Bellevue Hospital in June, 1929, complaining of masses on both sides of the neck, of three weeks' duration. She had had a persistent mild cough for six months, accompanied by profuse night sweats, and an occasional shooting pain in the right shoulder. She had lost some weight, and for the previous six months had felt lazy and indisposed to work.

Physical examination showed a thin, pale, young white female, with noticeably swollen glands on both sides of the neck, the swelling being greater on the left side. The swellings were made up of discrete nodes. The spleen was palpable one inch below the costal margin; the liver was not palpable. Small glands were palpable in the inguinal and femoral areas, but none in the epithrochlear area. The heart appeared normal; the pulse was 100; the respiration, 32; and the temperature, 100. Resonance of both lungs was somewhat diminished. No other abnormalities were discernible.

Roentgen examination showed a mediastinal mass extending into the right upper pulmonic field, measuring about 7×7 cm.

Wasserman was negative. Blood count was: white blood cells, 10,000; red blood cells, 3,800,000; polymorphonuclears, 88; lymphocytes, 10; eosinophil, 1; basophil, 1. Urine was normal. On June 14, 1929, a node from the neck was removed for pathologic examination. This proved the condition to be Hodgkin's.

The patient was treated systematically with deep x-ray therapy. The factors used were 200 kv., 4 ma., 0.5 mm. Cu plus 1 mm. Al filter. The patient was treated twice weekly, a dose of 200 r with back-scattering being given at each treatment. Irradiation was administered to the right and left neck, anterior and posterior mediastinum, a total dosage of 800 r being given to each area. In addition, one dose of 200 r was given over the right and left inguinal and anterior spleen areas.

In December, 1929, the general condition of the patient was excellent. She had no complaints and the swollen nodes had practically subsided. Roentgen examination of the chest showed moderate glandular enlargement at the right root.

At the end of January, 1930, the patient again reported to the clinic with a generalized itching and eruption of the skin which, however, soon cleared up.

On April, 1930, the patient complained of a cough and slight enlargement of the glands in the neck. A dose of 400 r units of x-ray radiation was again given to the neck, axillæ, and mediastinum. The patient then remained comparatively well until December, 1931, one and one-half years after the first visit to the clinic. A routine roentgen examination of the chest at this time showed destruction of the tenth dorsal vertebra. This area was irradiated although the patient did not display any symptoms referable to the lesion (Figs. 1 and 2).

In March, 1932, the patient complained of pain in the lower back. Examination revealed a mass opposite the mid-dorsal spine on the left side. Treatment was again instituted, and 400 r units of irradiation were given to the left neck, lumbar and lower dorsal areas.

On June 6, 1932, the patient suddenly developed complete paralysis, extending downward from the level of the fourth dorsal vertebral area. There was a mass opposite the middle lumbar vertebræ about the size of a lemon. Her temperature varied from 103 to 105 degrees.

The patient was again given x-ray therapy, 1,200 r units being administered to the mid-dorsal spine. On Aug. 8, 1932, the patient died.

At autopsy, the following findings were noted: general cachexia and slight jaundice; definite signs of Hodgkin's disease, with involvement of the cervical, epithrochlear, lumbar, and suprapancreatic lymph nodes. There was involvement of the pancreas, liver, spleen, thymus, dura of the spinal cord and the spinal cord, and the tenth dorsal vertebra. There was a left hydrothorax with subpleural hemorrhages. The aorta was atheromatosed. The kidneys showed cloudy swelling. The ureters were dilated and cystitis was present in the bladder. The mesenteric lymph nodes were tubercular in character. Examination of the involved bones of the spine showed generalized osteosclerosis.

Diagnosis: Hodgkin's disease with vertebral involvement.

Case 2. J. F., a white male, aged 23 years, was admitted to Bellevue Hospital on Feb. 2, 1932, complaining of a lump in the left axilla of two weeks' duration, which was rapidly increasing in size. Eighteen months prior to admission, the patient first noticed a swelling in the axilla. A node was removed at that time and a diagnosis of Hodgkin's disease was made. However, the patient had had no subsequent x-ray treatments. Two months later he went to another institution where another gland was removed. The same diagnosis was made and there roentgen therapy was given to the areas involved, treatments being administered once every second week, and later on, every third week. He did not respond to these treatments and entered Bellevue Hospital for relief.

Physical examination revealed a fairly well-developed, and rather well-nourished man, appearing, however, chronically ill. There were some enlarged glands in the right neck and right axilla, with a draining sinus at the site of an old operation wound. The right arm was swollen. There were no palpable glands in the left axilla. The heart and lungs were apparently normal.

Roentgen examination on Feb. 5, 1932,

three days after admission, showed the lungs clear, but some widening of the superior mediastinum on the right side. X-ray treatment was advised and the patient received irradiation to the right axilla and the mediastinum, 800 r units being administered to each area.

In March, 1932, the patient was fairly well and the sinus in the axilla was healing slowly. Edema of the arm had subsided. Tuberculosis investigation proved negative and a biopsy of a lymph node confirmed the diagnosis of Hodgkin's. The patient was treated periodically until Dec. 8, 1932.

On Dec. 27, 1932, the patient was readmitted to the hospital complaining of severe abdominal pains. In rapid succession, he developed, first, irritating signs, and then destructive signs, which were interpreted by the neurologist as evidence of involvement of the sixth thoracic vertebra. He had numbness below that area and could not move his lower extremities; urinary and intestinal incontinence was not established; analgesia and thermia, absence of vibratory sense from the tenth dorsal vertebra down; bilateral Babinski and ankle clonus; poor control of urination; vague sensory changes up to the sixth dorsal vertebra. Marked tenderness of spine at the sixth dorsal vertebra.

A diagnosis was made of metastatic involvement of the spine at the level of the sixth dorsal vertebra. X-ray treatment to the involved spinal areas was administered.

On Jan. 1, 1933, the patient developed cystitis, and on Jan. 2, 1933, absolute paralysis from the sixth dorsal vertebra developed. No reflexes were obtainable and bed sores developed over the sacrum.

On Jan. 3, 1933, the patient complained of pain in the lower chest reaching from back to front, with difficulty in expansion. On Jan. 10, 1933, the patient expired.

Necropsy showed the following: lymphogranulomatosis involving cervical mediastinal, retropleural, and retroperitoneal lymph nodes; compression of spinal cord at the level of the sixth dorsal vertebra; congestion of the lungs; right obliterating adhesive pleuritis; cloudy swelling of the myocardium, splenomegaly, fibrosis, congestion; chronic passive congestion of the liver; cloudy swelling of the kidneys with dilatation of the ureters and urethritis; hemorrhagic cystitis; decubitus ulcers; lymphodermia of cervical, axillary, and inguinal nodes.

Diagnosis: Hodgkin's disease, with bone involvement.

Case 3. McL., white male, aged 30 years, married, entered Bellevue Hospital in May, 1933, complaining of masses in the neck and groins.

Onset in February, 1933, with masses in the neck, followed by appearance of nodes in both inguinal regions, swelling of ankles, weakness, anorexia, cough, slight change in voice, and loss of weight.

A node from the neck was removed, and histologically proved to be Hodgkin's.

Physical examination showed a pale, young, white male, in fair general condition. There were soft matted nodes palpable in the left neck and both inguinal areas. Edema of the right ankle was noticeable. An x-ray examination of the chest showed no abnormalities. High voltage x-ray was given to the right and left neck, right and left inguinal areas, and anterior mediastinum, 200 r units per treatment, until 800 r units were administered.

By October, the patient felt much better and the nodes were smaller. On Nov. 14, 1933, the patient was re-admitted to the hospital complaining of shortness of breath. He exhibited marked pallor and emaciation. The veins of the abdomen and chest were extensively dilated. The cervical, supraclavicular, axillary, and inguinal nodes were enlarged and movable. The abdomen was distended and tense. The liver was palpable at the level of the umbilicus, but was soft. The spleen was soft, being enlarged three inches below the costal margin. The right lower extremity and the scrotum were markedly edematous. Dullness on both sides of the chest on percussion, suggesting pleural effusion.

X-ray therapy was started and periodi-

cal paracentesis of the chest was carried out. However, at no time was there clinical or x-ray evidence of involvement of the spine.

The patient died on Jan. 7, 1934, and at autopsy there was found a lymphogranulomatosis of the liver and spleen; involvement of the retroperitoneal and deep inguinal nodes; mediastinal, peritracheal and peribronchial lymph nodes, and slight involvement of epithrochlear, supraclavicular, and axillary nodes. The third lumbar vertebra did not look normal and was removed. Microscopically, it showed lymphatic myelosis of the marrow. On cutting, a dark brown area of softening about one centimeter in diameter was found in the marrow. The cord was not adherent to the dural coverings. There was massive bilateral hydrothorax and hydropericardium and atelectasis of both lungs, with serofibrinous pleuritis of both lungs. There was massive edema of both lower extremities, scrotum, penis, and abdominal wall.

Diagnosis: Hodgkin's disease with bone involvement.

CONCLUSIONS

(1) Bone destruction in Hodgkin's disease is a frequent occurrence, and therefore, routine examination of the skeleton should be done in each case.

(2) Pain from bone involvement is frequently relieved by the administration of x-ray therapy.

(3) Three cases with involvement of the spine are herewith reported.

(4) Autopsy confirmed the diagnosis in each case.

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THE DIAGNOSIS AND ROENTGEN TREATMENT OF CARCINOMA OF THE HEAD OF THE PANCREAS[1]

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OF all the neoplasms which are observed to occur in the pancreas, carcinoma is by far the most frequent. Sites of predilection are, in the order named, the head, the body, and the tail of the organ. Vorhaus asserts that approximately two-thirds of all primary pancreatic carcinomas found surgically are located in the head. According to Ewing, tumors confined to the body of the organ are much less common. Scholz estimates the incidence of carcinoma of the tail of the pancreas at about 1.5 per cent of pancreatic carcinomas. Hoffman, in 1934, set the mortality from cancer of the pancreas at not less than 3 per cent of the total mortality from all forms of malignant diseases in the United States. Hoffman is of the opinion, therefore, that carcinoma of the pancreas can no longer be referred to as a rare disease.

While there is occasional evidence to the effect that males are more often affected than females, apparently the disease displays no particular preference for either sex. As is true of most carcinomas, the disease is decidedly one of the late years of life.

The cause and nature of carcinoma of the pancreas is still the subject of wide controversy. Hulst insists that cirrhosis constitutes a predisposing condition. Leriche characterizes cholelithiasis or pancreatic calculus as an occasional incidental factor of etiologic importance. Ewing, who bases his opinion upon analogy with the liver, believes that carcinoma of the pancreatic parenchyma has its inception in a functional hyperplasia following cirrhosis, and that carcinoma of the ducts results from chronic irritation and stasis in the same. Ewing also suggested that tumors might sometimes arise from aberrant glandular tissue. Horgan sought to establish a relationship between carcinoma arising in the islands of Langerhans and the chronic pancreatitis frequently found in case of peptic ulcer.

In general, the prodromal stage of primary pancreatic carcinoma is mild, the disease usually manifesting itself at the outset in the guise of a gastro-intestinal affection, with subsequent marked signs of intestinal indigestion, pain, vomiting, emaciation, anemia, and progressive debility. When the tumor is located in the head, the classical Bard-Pic syndrome of profound, progressive, or painless jaundice, dilated and palpable gall bladder, and accelerated cachexia, with rapid emaciation and asthenia, makes its appearance in the majority of cases. Kiefer, who, in 1927, reported 27 cases of carcinoma of the pancreas out of a series of 33 cases of pancreatic malignancy observed and studied by him at the Peter Bent Brigham Hospital, enumerated the most common symptoms in their order of frequency, as cachexia (including loss of weight, anorexia, weakness, and anemia), jaundice, pain usually with or without vomiting, indigestion, and constipation. Diabetes has recently been demonstrated in conjunction with carcinoma of the pancreas in approximately 20 per cent of the cases.

With respect to the pathology of primary pancreatic carcinoma, three forms are differentiated, namely, (*a*) the scirrhous, (*b*) the medullary, and (*c*) the gelatinous. The first form is readily confused with pancreatic sclerosis, since it is of tough consistency, hard, and can be differentiated only microscopically; the medullary form is soft by reason of the lesser involvement of connective tissue, while the gelatinous form results from regressive processes. According to Weiss and his associates, the condition may be classified histogenetically

[1] From the Radiologic Clinic of Drs. Grover, Christie and Merritt.

as originating (1) in the epithelium of the excretory ducts, (2) in the glandular parenchyma, and (3) in the islands of Langerhans, although they point out that the latter are peculiarly resistant to carcinoma, hence its occurrence in that particular locality is extremely rare.

In cases in which jaundice is present, perhaps clinically the most important of the factors involved in the differential diagnosis is obstruction of the common duct by gallstones. Jaundice in malignancy is practically always progressive and unremitting, while in cholelithiasis it is usually intermittent. Cachexia, present in practically all cases with ultimate production of jaundice, is also an important differential sign, although it should be remarked that excessive loss in weight sometimes ensues in cases of chronic jaundice resulting from gallstones. Palpation of a distended gall bladder in conjunction with progressive jaundice is generally regarded as fairly conclusive evidence of the existence of carcinoma, the diagnosis being rendered even more certain when a tumor mass is palpable in the region of the head of the pancreas, or if ascites subsequently develops. Infectious and catarrhal jaundice are differentiated by their dissimilar onset and course. Chronic pancreatitis may simulate carcinoma, it proving difficult sometimes to distinguish between them even following exploratory laparotomy unless metastases are found. Pancreatic cyst is excluded by reason of its physical characteristics and the customary absence of cachexia.

Despite the remote anatomic position and comparative inaccessibility of the organ, roentgen examination affords a fairly reliable means for the diagnosis of carcinoma of the pancreas. According to Kudisch, the first roentgen sign of an enlargement of the pancreas (or its head) is a widening of the arc which the duodenum describes, while pressure from the enlarged body and tail of the pancreas causes the stomach to assume the form of the so-called "cascade stomach," and with the distended abdomen there is revealed an extensive lacunar defect, the ascending portion of the duodenum being compressed, and the remaining portions considerably attenuated. Teschendorf points out that in presence of existing pneumoperitoneum, differential diagnosis between gall-bladder tumors and tumors of the pancreas is always possible when the liver shadows can be distinguished with sufficient clarity from the shadow of the tumor. Eisler adduces among other diagnostic criteria for differentiation between tumors of the gall bladder and pancreas changes in form and position of the contrast-filled gastro-intestinal tract, these changes appearing more frequently in the pylorus and duodenum in the case of tumors of the gall bladder, and more often in the body of the stomach, and also in the duodenum in the case of tumors of the pancreas. Engel and Lysholm recently described a novel method for radiographic observation of the pancreas by inflation of the stomach with carbon dioxide gas, produced by administration of an ordinary effervescing powder given on an empty stomach with a mouthful of vichy and a warning not to belch. By this method, soft parts, such as tumors, nodules, or other convex surfaces may be seen bulging into the gas-filled stomach. Roentgen-ray examination with the opaque meal or pyelogram may assist in exclusion of cancer of the gastro-intestinal tract or of the left kidney.

Save in comparatively rare instances, surgical treatment of malignant neoplastic diseases of the pancreas seldom extends beyond the institution of palliative measures such as anastomosis for the relief of secondary obstructive symptoms. Coller and Winfield report the results of biliary intestinal anastomosis for obstructive jaundice in 30 patients suffering from cancer of the head of the pancreas. In their group the hospital mortality was approximately 25 per cent, while the patients who left the hospital survived on an average of about seven months. Symptoms of jaundice, pain, and pruritus were generally ameliorated in the survivors, relief from pain having been noted in approximately 78 per

per cent, from pruritus in 100 per cent, and from jaundice in about 94 per cent. Two patients were alive five and four years, respectively, after operation. Judd and Parker, in 1928, published an analysis of 137 consecutive cases of biliary intestinal anastomosis for obstructive jaundice, 34 of which proved to be carcinoma of the pancreas. Of these 34 patients, one who survived the operation lived 18 months, one 15 months, one 9 months, one 7 months, two 6 months, one 5 months, two 4 months, and one 3 months. Nothing further was heard from four following their discharge. All the other patients in the group failed steadily after operation and eventually died.

Instances of radical operation for the removal of malignant growths of the pancreas thus far recorded are extremely rare. According to Gordon-Taylor, only 12 cases of partial pancreatectomy for cancer of the head of the pancreas were found in the literature up to 1930, the operation having resulted fatally in all but one case (sarcoma). He cites four cases of removal of malignant tumors of the tail of the pancreas, with two deaths, and two cases of successful removal of massive cancer of the body of the pancreas. Gordon-Taylor also reports a third equally fortunate case of subtotal pancreatectomy which he himself performed for the removal of a massive carcinoma of the pancreas from a male patient of 54 years, who when last seen, more than two years after operation, had gained in weight and appeared in excellent health.

In view of the unfavorable end-results from surgical intervention, palliative and radical, in recent years, attention has been turned to the possibility of the employment of some form of radiation for the cure of carcinoma of the pancreas. In 1927, Miramond de Laroquette reported what is probably the first recorded case of apparently successful treatment by radiotherapy combined with complementary diathermy of a tumor diagnosed macroscopically following exploratory laparotomy (without biopsy) as carcinoma of the pancreas and stomach in a woman of 68 years. She was said to have been discharged in perfect health and with ability to resume her former occupation at the end of eight months from the date of initial institution of the physiotherapeutic treatment. The technic employed is described briefly as follows: cross-fire radiation to the left hypochondrium (fortunately quite accessible owing to emaciation); Coolidge tube; spark gap, 54 to 40 cm., with 5 mm. aluminum filter; 1,200 r (Solomen) to the skin at each treatment, 700 r approximately reaching the tumor, about 40 to 50 r being absorbed per cubic centimeter. Diathermic treatment consisted of application of large electrodes (abdominal and dorsal) above and below the left hypochondrium (intensity 1,500 milliamperes, 30 minutes). In 1934, Handley presented an account of his experiments with the treatment of seven cases of cancer of the pancreas by implanted radium. Of these cases, one (in which the diagnosis was rendered as certain as possible in the absence of biopsy by the presence of isolated nodular deposits outside the main mass at the time of operation) had remained cured for a period of about fourteen years. In a second patient, life was prolonged for two years. In a third case, the patient appeared well ten months after radium treatment. In the other four cases, death occurred shortly following laparotomy, presumably from simple asthenia. Handley advised the use of three tubes, each of 2 mg. element, with removal after five days, the total dosage amounting to 720 mg.-hours.

In the case which we are about to report there was no biopsy because of the hazards entailed. However, our diagnosis of carcinoma of the head of the pancreas was based upon the opinion of a highly competent surgeon who performed the initial and a subsequent operation. His surgical observations, added to the clinical data, in our belief undoubtedly point to the presence of malignancy prior to roentgen-ray treatment. The failure to discover evidence of malignancy at autopsy argues just as indubitably in favor of its retrogression under the influence of roentgen therapy.

Accordingly, although the case is of suggestive rather than demonstrative value, it is presented with the hope that it will serve as an incentive to further investigation of the potentialities of roentgen therapy of pancreatic neoplasms.

HISTORY OF CASE

A white, married woman, 47 years of age, presented a history of epigastric disturbances during the previous two years, followed by a very recent appearance of painless jaundice, with clay-colored stools and vomiting. At operation, on Aug. 15, 1933, Dr. H. H. Kerr found an enlarged, tense gall bladder, but no stones. The head of the pancreas was very hard and slightly nodular in its lower portion; the tail of the pancreas was soft. The liver was enlarged; no metastases were noted. Long loops of jejunum were brought around the omentum, and the transverse colon was anastomosed to the gall bladder. The patient's husband was informed that his wife was suffering from cancer of the pancreas and had six months to live.

On Aug. 30, 1933, the patient was referred to us by Dr. Kerr. Beneath the recently healed skin incision there was a large hard tumor palpable in the epigastrium. Roentgen-ray therapy was advised and accepted. In the first series, extending from Aug. 30 to Sept. 18, 1933, the patient received a total dosage of 4,500 r (2,250 r to the anterior and 2,250 r to the posterior pancreas; 1,800 r tumor dose) with the following factors: 220 kvp., 20 ma., 50 cm. distance; Thoræus tin filter equivalent to 2.0 mm. copper, 250 r (measured in air) to alternate 15 × 15 cm. anterior area and 20 × 20 cm. posterior area. The patient's general condition improved during treatment and the vomiting stopped.

In September the patient appeared much stronger and was able to walk about. The tumor was no longer palpable. Skin reaction was just under vesication, and by October the patient declared she felt well and took two hearty meals daily, with consequent gain in strength. The jaundice had disappeared and the skin reaction had healed.

In December, 1933, the patient declared she felt fine, did her own housework in the absence of her maid, weighed 140 pounds (a gain of 18 pounds since completion of roentgen therapy), and no longer knew what it was to be ill.

In March the patient reported that she felt well, with good appetite, normal stools, and excellent general condition. She passed an uneventful summer at the seashore and returned to us in September for treatment of mild jaundice, without pain, or induration in the epigastrium. Weight was 145 pounds; health in general was excellent. On Oct. 8, 1934, gastro-intestinal and cholecystographic examinations were essentially negative.

In November, because of the persistent painless jaundice and vomiting, it was decided that the patient probably had liver metastasis although the liver was not palpable. Because the original pancreatic tumor had been radiosensitive, it was decided to irradiate the liver, repeating the same dose delivered to the primary tumor. From Nov. 6, 1934, to Dec. 10, 1934, 2,400 r was delivered to the anterior liver and 2,150 r to the posterior liver. The patient tolerated the treatments very well, but continued to lose weight and vomited daily, although she was able to come in from her home for treatments each day. A slight decrease in degree of jaundice was noted.

In December, 1934, the patient declared she felt much better. The jaundice had disappeared completely except for slight icteric tinge of sclera. There was no vomiting, although the patient became nauseated if she ate more than a few simple foods.

In February, 1935, the jaundice had subsided. Appetite was improved, with consequent gain in strength.

On Feb. 25, 1935, the patient announced that she had on several occasions vomited food taken twelve hours previously.

On March 6, 1935, roentgen-ray examination of the stomach showed obstruction

at the junction of the second and third portions of the duodenum, the portion of the duodenum visualized being distended to about three times the normal size. The stomach was normal. No growth was palpable in the region of the pancreas. This obstruction was regarded as probably malignant.

An exploratory abdominal operation (Dr. Kerr), done on March 14, 1935, revealed the following: the liver was somewhat mottled in appearance but entirely smooth over all lobes. There were a few filmy adhesions between the liver and the abdominal wall and many adhesions at the site of the previous operation. The duodenum was palpated but no nodules could be felt. The pancreas was entirely normal in appearance, size, and texture. Anastomosis between the gall bladder and the small intestine appeared entirely satisfactory except for the small bowel obstruction in this region. A gastro-enterostomy was performed by bringing up a loop of small bowel distal to the anastomosis between the jejunum and the gall bladder. At the time of the operation Dr. Kerr stated that a very few filmy adhesions, readily broken up, refuted for all time the argument that properly administered radiation produces adhesions and renders operation more difficult. Following the operation the patient did exceedingly well. Jaundice disappeared, there was no more vomiting, she took three satisfactory meals daily, and gained strength rapidly. Luminal was required for insomnia. A small stitch abscess developed in the incision.

In April, 1935, there remained a small ulcer in the line of incision, with a small sinus running up under the latter, dirty in appearance and containing a small amount of necrotic tissue. The patient was advised to come in daily for dressings and inductotherm therapy.

In July, 1935, the patient went to the seashore, feeling fairly well at the time of her departure. During the latter part of July, she began to run a septic temperature, became very toxic, and died on Aug. 3, 1935.

REPORT OF AUTOPSY

There were no deformities but a scar in the midline above the umbilicus.

Thorax.—About 60 c.c. of straw-colored fluid was found in the right pleural cavity. Right lung, upper and middle lobes, was negative. Lower lobe was intensely congested and solidified, the process resembling terminal pneumonia. There were six areas that either projected over the surface or were palpable as nodules in the parenchyma, these proving on section to be recent abscesses. Pleura of the left lung revealed a number of petechial hemorrhages. Upper lobe was normal. Lower lobe was somewhat congested, with three abscesses. No fluid was found in the pleural cavity. Peribronchial lymph nodes were slightly enlarged without evidence of malignancy. Thymus was atrophied. Heart was small and flabby, but showed no pathology.

Abdomen.—No peritonitis. Stomach was slightly dilated. There were no ulcers. Posterior gastro-enterostomy had been done. Ostium was widely open. Dense adhesions were found about gall-bladder region, extending to the anterior abdominal wall and involving loops of the small intestines, ascending and transverse colon, and also round the common duct and head of the pancreas—evidently faulty mechanics, but no obstruction. Cholecystenterostomy had been done, with a pin-point ostium between the gall bladder and the intestine; also an entero-enterostomy. The gall bladder was small, with thickened walls, and embedded in a mass of adhesions, but with no acute pathology, and contained no bile, but a whitish fluid. There were a number of stones. The cystic duct was definitely occluded. The common duct was not occluded, although dilated, with thickened walls. Radices of branches of duct system revealed a definite choledochitis. The liver appeared smaller than normal, smooth, pale, and mottled. Adjacent to and on the right of the gall bladder there was a large abscess filled with foul smelling pus, quite superficial, without communication with the gall bladder, and apparently very re-

cent. Kidneys and spleen revealed no definite pathology. There was no involvement of the retroperitoneal nodes. The genital organs showed no pathology. There was positively no carcinomatous involvement either here or elsewhere.

Anatomical Diagnoses.—(1) Terminal pneumonia. (2) Multiple abscesses (metastatic) of both lungs. (3) Abscess of liver. Hepatitis. (4) Chronic cholecystitis and cholelithiasis. (5) Choledochitis and pericholedochitis. (6) Secondary anemia.

Histologic Examination.—No malignancy of the pancreas; it showed a chronic interstitial pancreatitis.

SUMMARY

Clinically the patient presented evidence of carcinoma of the pancreas. This was verified by surgical exploration. A cholecystojejunostomy was done to relieve the biliary obstruction.

The patient was given intensive postoperative roentgen-ray therapy, with complete disappearance of the tumor, and apparent clinical recovery for a period of one year, when she developed signs and symptoms of liver metastasis. She was given a second intensive course of roentgen-ray therapy over the liver, with amelioration of all symptoms for a period of two months. She then developed signs of small intestinal obstruction. Operation by the same surgeon who made the original diagnosis revealed no evidence of malignancy in the abdomen. There was, however, an upper small bowel obstruction due to the previous cholecystojejunostomy. The obstruction was relieved by anastomosis.

The patient did well for a period of three and a half months, except for a stitch abscess developing in irradiated tissue. She then developed a subdiaphragmatic abscess by direct extension from the stitch abscess, followed by miliary abscesses throughout the lungs, which were the cause of death, two years after diagnosis and radiation therapy.

No evidence of malignancy was found at autopsy.

The case is presented to stimulate further trial of roentgen therapy in carcinoma of the pancreas.

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TREATMENT OF SOME INFECTIONS BY MEANS OF THE ROENTGEN RAY[1]

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THERE is such a vast amount of literature, principally in German and French, in the last few years concerning both experimental and clinical experiences with radiotherapy in a galaxy of inflammatory diseases in which roentgen therapy has been shown to be of value, that we feel embarrassed to advise our confrères of the many indications therefor.

We seem to sense that there is running through their minds the idea that radiologists are over-enthusiastic or trying to get a corner on the practice of medicine and advertise that radiotherapy "is good for what ails you."

But when the experienced practitioner stops to analyze what has been gleaned from radio-physico-chemical-biologic experimentation as well as from clinical observations, when he remembers that every cell in the body has its own variable range of sensitivity to some form of radiation, that the chemistry of the fluids which bathe and nourish the cells likewise may at times undergo varying degrees of chemical and electrical changes from radiation, and that the radiosensitivity of the tissues of the body is partly dependent upon ever-changing physiologic and pathologic states, he may find there is some justification for serious consideration of roentgen therapy in inflammatory conditions.

In this short paper we shall be able to mention or to discuss only very briefly some of the high-light details concerned in the radiation therapy of inflammatory diseases.

First we find ourselves asking the following question:

(1) Is the inflammatory process we are called upon to relieve due to primary infection of the tissue or organ involved in the process? Or is it due in whole or in part to an extraneous cause in some other organ or tissue of the body?

(2) Then, in the radiation treatment of a local inflammatory process, should it or some other tissues or organs, or even the whole body be subjected to radiation?

(3) What are some of the conditions of organs and tissues, the impaired function of which may serve to involve other tissues or organs in inflammatory processes?

(4) What form of radiation is indicated in the numerous inflammatory conditions met with?

(5) What doses are best? Is there any great limitation to dose so long as one keeps within the limits of safety so far as the skin is concerned? How much repetition of dose?

Attempts to answer these questions are being made in many laboratories and clinics in various parts of the world, but the complicated vital processes which are going on in the body and their modifications from radiation probably never will be thoroughly understood—surely not in this generation and probably not in many to come.

The internal mechanism of the atoms composing living tissue, and their momentarily changing reactions and interactions with internal and extraneous influences at any one time, cannot be precisely enough measured or computed to make this understanding possible.

The tendency has been to treat directly local manifestations of infections, such as the many forms of dermatitis, acne, furuncles, carbuncles, erysipelas, parotitis, sinusitis, mastoiditis, tonsillitis, pneumonitis, adenitis, etc., with arbitrarily designated doses of $^1/_{20}$ to $^1/_2$ skin erythema dose of x-rays, filtered or unfiltered, with varying time factors and intervals of repetition.

Skilled radiologists, more or less familiar with the diseases they have thus treated, have reported curing a very large percentage of such cases, but there is still

[1] Presented before the Radiological Society of North America, at the Twenty-first Annual meeting, in Detroit, Dec. 2–6, 1935.

a percentage of around 15 to 50 in which they acknowledge they have failed to accomplish satisfactory results.

Many different factors must be considered in connection with these failures: Dosage of radiation, repetition of dose, fractioning, size and location of area involved, stage of the pathology concerned, and its location and etiology.

There is much experimental and clinical evidence to show that, in the treatment of inflammations, the probability is that the dose should be selected perhaps with even greater care than in the case of the treatment of neoplasms. But up to the present time we have not had sufficient research to learn just what are the most effective doses in the different types of infections we are called upon to treat.

For instance, let us consider the experiments that have been made by irradiating *in toto* the bodies of animals. Under such circumstances a mouse erythema dose would produce grave injuries to the primitive forms of both the red and white series in the bone marrow, and death would follow.

According to P. Cottenot and F. Sluys,[2] who quote Regaud and Lacassagne, these primitive forms of both the red and white blood elements in the bone marrow react (under total irradiation) identically. If the dose is not too heavy, the megacaryocytes are not necrosed at first, but, on the contrary, are more active, which explains the increase of blood platelets in the circulating blood and the consequent increased coagulability. Depopulation of the bone marrow follows in a few days, and if the dose is moderate and not repeated, repopulation of both white and red elements takes place in fifteen days. This is a warning to us to be careful about repeating doses, at least when irradiating the whole body.

However, the lymphoid system in animals irradiated *in toto* is much more sensitive than the most primitive elements of the bone marrow.

[2] Biological Action of Total Teleroentgenotherapy. Jour. d. radiol. et d'electrol., July, 1936.

In these cases, immediately after irradiation the lymphoid tissue shows pyknosis of the nuclei, abnormal karyokinesis, necrosis, vacuolization, and so forth. Depopulation of the lymph follicles takes place rapidly but, as in the case of the marrow, with a single moderate dose which is not repeated or fractionated, repopulation is observed in fifteen days.

According to these authors, as a result of this action on the marrow and lymphatic system, there is an immediate and transitory leukopenia because of destruction of lymphocytes, followed by propagation of leukocytes, with a relative and absolute increase of polymorphonuclears, which comes about by acceleration of the maturation of the elements and their sudden distribution into the circulation.

What follows thus in irradiation of the normal body *in toto* no doubt follows in lesser degree, perhaps with some modification, after irradiation of smaller areas of the body in pathologic conditions, many of which have been discussed in the literature.

The location of the infection and the many factors which may predispose to the infection are important details in prescribing the dose of irradiation, the part of the body to be irradiated, and its area. Many theories and some facts must be considered in this connection. We cannot do more than refer to some of them here.

Perhaps the most popular theory, that held by Desjardins, as to the mode of action of irradiation in infections, is its destructive effect on the infiltrating lymphocytes, marshalled for defense, which liberates protective bodies (enzymes, proteins) which, in turn, exercise a deterrent influence on the growth and development of bacteria.

But does that explain all? Hardly. Let us consider what takes place in a boil or carbuncle after irradiation. It is swollen, tense, hard, and painful because of its overpopulation of leukocytes. The x-ray is applied; very soon large numbers of this increased population are killed, the tension is relieved and so is the pain. A freer cir-

culation is allowed, and consequently a better metabolism follows and recovery quickly takes place.

In some cases of infection there appears to be an endocrine association, such as in acne, dermatitis dysmenorrhoica, mastitis, and so forth. In such cases, improved results might accrue from treating the proper endocrine, about which we have so little information. Sterilization by x-ray often relieves mastitis.

The theory that some infections of the skin are due primarily to pathology involving the vegetative nervous system is seemingly more and more demonstrable. As an example, we may refer to that very chronic pruritic, heretofore quite intractable skin disease, known as lichen planus, which apparently falls into this group, and instead of treating the local eruptions of this disease in the skin and mucous membranes, we now treat the spinal nerves with considerable success.

In our practice we have applied to the spine 75 r (95 or 100 kilovolts, filtered through four millimeters of aluminum at about thirty centimeters distance) repeated once a week. This is, we admit, a very arbitrary formula, and the only reason we can give is that we have tried it in a number of cases. It has worked satisfactorily. We have no doubt the same results could be accomplished with 220 kilovolts, filtered through two millimeters of copper, as well as with 95. In order that we might not complicate the biologic reaction, we have selected the interval of a week for repetition of the dose, to give the preceding one what we consider a sufficient time to react before applying another treatment.

Indeed, in our hospital work we are now using higher voltages in the treatment of several skin diseases with quite as satisfactory results as we have had with the lower voltages. We did not begin this work from choice, but, upon installing new equipment, we decided we wanted only shockproof apparatus, and pending the development of such for lower voltage current, we used our high voltage.

We see no good reason for continuing the high voltage in this class of work because at present no improvement has been seen in results over those produced by the lower voltages. Besides, we must consider that with higher voltages we are carrying larger doses to greater depths than with lower voltages, and while our high voltage surface dose may be small and quite inconsequential in the skin, there is the possibility that it may be sufficiently active in the deeper sensitive tissue not to do any irreparable damage to the tissues themselves, but to produce by-products in the circulating fluids, the reaction of which in the pathology we are treating is unknown.

Then, too, it is not good tube economy to use higher voltages when lower voltages will answer as well.

The beneficial results of roentgen therapy in bronchial asthma are well known. Some authorities have argued that the best results in this difficulty come from the treatment of the spleen; others, that they come from direct treatment of the chest only. Of late, the tendency is to consider that the vegetative nervous system is responsible, and that the treatment of the latter is what brings about the cure.

Of course, the chest or the spleen could not be treated without affecting the vegetative nervous system, and E. and H. Biancain[3] give some very good arguments based on animal experimentation and clinical experience to show that their results are due to modifications of the vagus tonus.

The same arguments might apply to radiation treatment of whooping cough, pneumonia, mediastinal adenitis, and so forth. It must be remembered, however, that it has been proven experimentally that moderate radiation of the liver and spleen increases the bactericidal power of the blood, an observation which probably also plays an important rôle. Modified secretions from radiated endocrine glands may also influence certain infections and inflammatory diseases. The thymus has been treated with some success in psoriasis.

The French are advocating teleroent-

[3] Jour. d. radiol. et d'electrol., September, 1935, p. 520.

gentherapy in doses of from 10 to 25 r to the body *in toto* for psoriasis, certain eczemas, parapsoriasis, premycosic mycosis-fungoides, leukemic dermatitis, general pruritus, urticaria, the object being to affect the whole hematopoietic system. We have personally seen some satisfactory results from this treatment in some of these diseases.

In conclusion, the value of roentgen therapy in infections of various kinds seems to be established.

The selection of dose, and its repetition and the region to be radiated appear to be matters of considerable importance. Moderate or small doses appear to build up resistance against infection in certain cases, while heavy doses in other cases (young growing tissue, for instance) would seem to break down resistance. The selection of the region and extent of the body to be subjected to radiation in different cases of infection are apparently matters worthy of further study.

PULMONARY CHANGES IN POLYCYTHEMIA VERA

By I. SETH HIRSCH, M.D., *New York City*

THE problem of the roentgen differential diagnosis of discrete lesions of the lung has been recently discussed in several publications (1–5). The disease producing these discrete lesions are enumerated. However, no mention is made nor have I been able to find reference in other publications to a discrete lesion which may be found associated with true or primary polycythemia. Such pulmonary lesions as chronic congestion, interstitial pneumonitis, or tuberculosis may be associated with a polycythemic blood picture, and the determination as to whether the polycythemia is primary or secondary becomes important because of the difference in prognosis. Secondary polycythemia may be a compensating beneficial mechanism, while in the primary disease arterial thrombosis and hemorrhage may occur and the disease may go on to myeloid leukemia or either secondary or pernicious anemia. The important and salient point in the diagnosis of primary polycythemia appears to be the increased blood volume, which varies from 130 to 300 c.c. per kilo of body weight. Such increased volumes never occur as a response of the blood to lowered oxygen tension.

The pulmonary lesion to be described has been found only in cases of true polycythemia in which the blood volume was markedly increased, the red cell count varying from 6 to 14 million and the hemoglobin from 100 to 145 per cent.

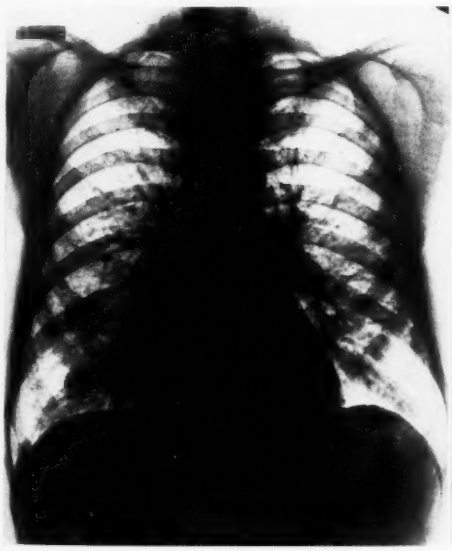

Fig. 1-*A*.

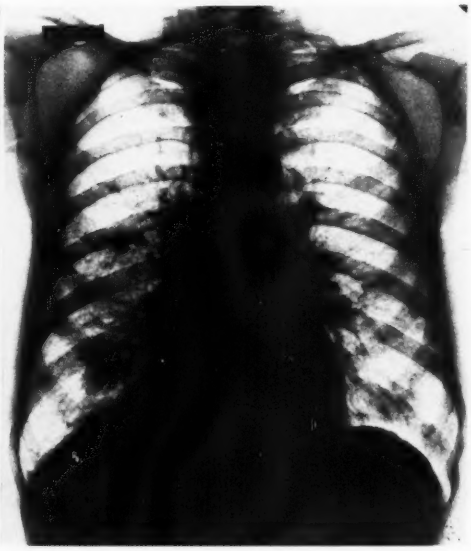

Fig. 1-*B*.

The pulmonary lesion referred to appears as circular shadows of varying size and density in any portion of the pulmonic field. By appropriate methods, it may be determined that this shadow is apparently due to a spherical lesion; it is sharply circumscribed, definitely outlined, and is not surrounded by infiltration. The lesions rapidly reach a certain definite density and then begin to fade out until they disappear completely, leaving no trace of their exist-

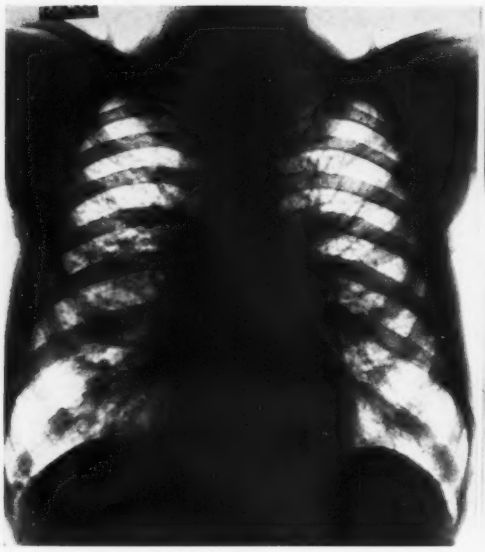

Fig. 1-*C*.

Fig. 1-*D*.

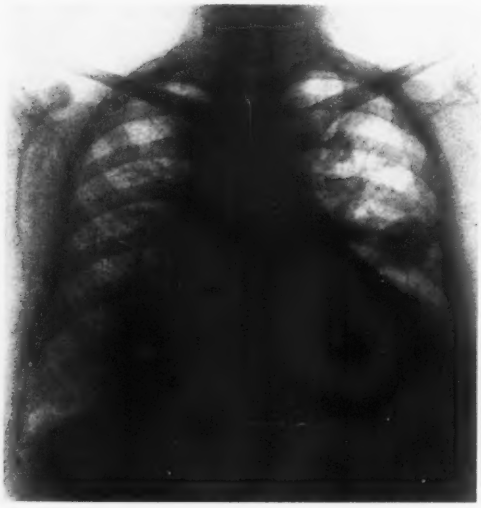

Fig. 2.

Fig. 3.

ence either by fibroid or calcific changes. The entire period from the appearance of such a lesion to its disappearance may be less than three weeks. This evanescence may explain why this change has not been described.

These sharply circumscribed shadows must be differentiated from a focus of metastatic malignancy and a conglomerate tubercle. It is difficult to state the pathologic nature of the lesion; most likely it is due to a subpleura thrombus or a small hemorrhage.

Figure 1 represents the lung changes in a case of true polycythemia. The patient was a male, aged 49 years, whose skin was a purplish-red color. The heart was normal, the blood pressure was 124/80. Both

the spleen and liver were enlarged. The urine showed a specific gravity of 1.008–1.030, with a trace of albumin, bile, and urobilin. The chemical examination of the blood showed non-protein nitrogen 38, sugar 80, icteric index 10, van den Bergh 0.7 unit. The pulmonary vital capacity was from 2,500 to 2,900 c.c. The bone puncture showed hyperplastic bone marrow. The Wassermann test was negative. The total blood volume was from 8,521 to 9,288 c.c.; the plasma volume, from 1,959 to 2,566 c.c.; the volume in cubic centimeters per kilo of body weight, from 164 to 178. The blood count showed over eight million red cells and from 105 to 108 per cent hemoglobin, and from 6,000 to 12,000 white cells with a normal differential count. The circulation time was 21 seconds; hematocrit, 70 per cent cells; sedimentation rate, 4 mm./45 min.; clot retraction, 45/50 min. Serum, colorless. There were no symptoms referable to the chest; no cough or sputum.

The first examination of the lungs was made on Nov. 30, 1932 (Fig. 1-*A*). This showed a large circular shadow, measuring 3 cm. in diameter, at the base of the right field, about opposite the anterior end of the sixth rib. To the outer side of this are two smaller circular shadows just below the level of the seventh rib. There are also two small sharply rounded shadows in the peripheral portion of the left upper field, one in the second interspace, and one about opposite the third, and similar shadows in the lower half of the left field. All these shadows are clear-cut, sharply defined, and of homogeneous density. Aside from a slight thickening of the pleura of the right lower lobe, there is no evidence of any other lesion in either lung.

Examination made 19 days later (Fig. 1-*B*) showed the shadows to have increased in density and sharpness. The shadows in the left field at this time appear as sharply circumscribed circular areas about one centimeter in diameter in its peripheral portion.

Six weeks after the first examination (Fig. 1-*C*), the shadows in the costophrenic area in the right field had disappeared. Those opposite the sixth rib were smaller. The shadows in the left field had all grown fainter and smaller.

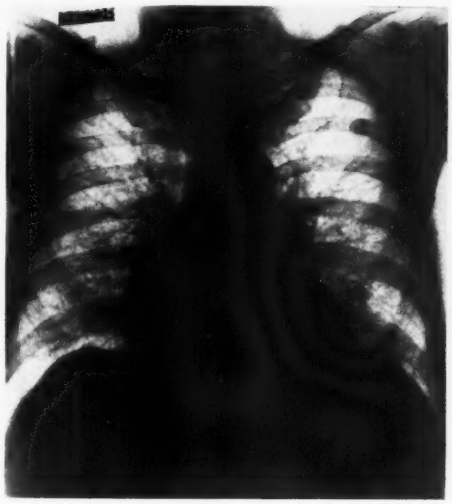

Fig. 4.

Fifteen weeks after the first examination (Fig. 1-*D*) there was no trace of the existence of the discrete circular shadows, and ten months after the first examination the lungs showed no trace of any lesion. This is the usual course of this particular type of lesion.

The majority of discrete circular shadows in the pulmonic fields, excluding metastases, are due to conglomerate tubercles (Figs. 2 and 3). Nodules of this nature may be present in cases of true polycythemia (Fig. 4). These conglomerate tubercles differ from the lesions in the case described, in that they have neither the sharp outline nor homogeneity of a true tubercle nor do they disappear as promptly without leaving a trace of either fibrosis or calcification.

A discrete nodular lesion may appear in polycythemia, persist for a considerable time, and undergo degeneration. Thus Figure 5 represents the examination of the chest of a female aged 50 years. The skin was purplish-red in color, the spleen was markedly enlarged, but the liver could not

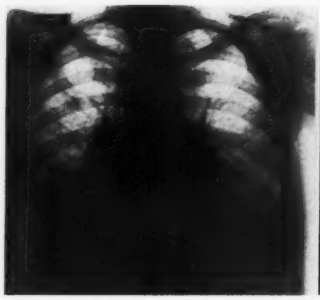

Fig. 5-*A*.

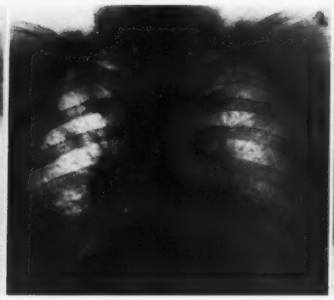

Fig. 5-*B*.

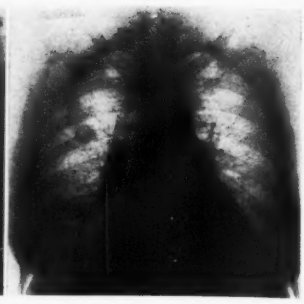

Fig. 5-*C*.

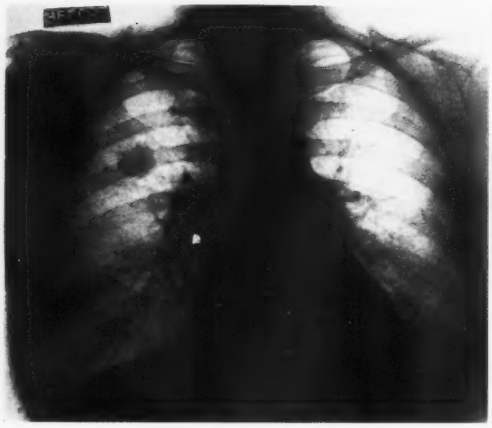

Fig. 5-*D*.

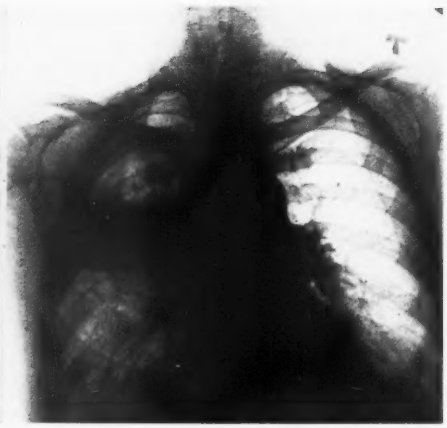

Fig. 5-*E*.

be palpated. The blood pressure was 160/76. The urine examination showed specific gravity 1.010–1.022, a trace of albumin, and no casts. The chemical examination of the blood showed non-protein nitrogen 23; sugar 80; creatinin 1.2. The total blood volume was 6,950 c.c.; the plasma volume, 2,700 c.c.; volume in c.c. per kilo, 163. The red blood cells varied from 6,800,000 to 7,400,000 and the hemoglobin from 95 to 112 per cent. There were 15,000 white cells, with a normal differential count. The coagulation time was 5 minutes and the sedimentation rate 2 mm./45 min.

The first examination, made on Aug. 25, 1932 (Fig. 2-*A*), showed only a slight thickening of the pleura of the right lung, but five months later (Fig. 2-*B*) a sharply circumscribed circular shadow appeared in the right upper field opposite the second rib anteriorly, which in ten months (Fig. 2-*C*) had attained the diameter of 3 centimeters. There were no other changes in the lungs.

About ten months later (Fig. 2-*D*), the nodule was still 3 cm. in diameter, and remained unchanged in size and density for nearly two years, when the patient began to have severe symptoms of temperature, chills, and dyspnea. The examination showed (Fig. 2-*E*) an abscess in the right upper lobe. No tubercle bacilli were found in the sputum.

SUMMARY

The lungs in true polycythemia may show two types of nodular lesions: one, a conglomerate tubercle which differs in no

way from the formation not infrequently found in the absence of polycythemia, and the other a sharply defined nodular lesion which appears to be characterized by multiplicity, homogeneity, and transientness, leaving a residue.

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MARCH FOOT OR PIED FORCÉ

By WARREN W. FUREY, M.D., *Chicago*

MARCH foot, as the name implies, was first noticed in soldiers on the march, particularly those carrying heavy packs. It was originally described in 1855, by Breithaupt, who called it "Fussgeschwulst." Many European and English writers have discussed the subject since, but only scattered reports of it can be found in American literature. Even before the advent of the x-ray, the condition was recognized as a fracture, but it was not until 1921 that Deutschländer noted the condition in civilians and reported six cases, all of them in women.

March foot is persistently edematous and painful, beginning rather insignificantly with soreness, and progressing in severity until the pain becomes intense enough to incapacitate the individual. It is usually accompanied by a spontaneous fracture of the second, third, or fourth metatarsal bone just proximal to the head. The pain and swelling are localized over the dorsum of the foot and centered over the shaft of the involved bone. The swelling pits very slightly on pressure, and the area is moderately reddened. In late cases, the bony callus about the site of fracture can be palpated.

The usual history is that of a painful swollen foot with progressive increase in the intensity of the symptoms, and not accompanied by a recent story of trauma. Many of these cases undoubtedly are treated as "painful feet," and passed over as fallen or weakened transverse arches, the real cause of the disability being overlooked.

The roentgen findings, after a history of this type, are rather alarming, as shown by numerous reports in which amputations have been done because of the suspicion of a malignant newgrowth. The roentgenogram of the early case shows a faint line of periosteal new bone, rather irregularly outlined, about the site of a linear fracture, which may be so insignificant as to escape detection. Later, the callus assumes a spindle-shape outline, out of proportion to the primary lesion. This, together with the absence of trauma, is undoubtedly the cause of the diagnosis of sarcoma.

Harold Dodd, of England, made an extensive survey of the English and European literature and reported his results, citing several new cases in the British Journal of Surgery, in July, 1933. One of his cases is briefly as follows:

Physical Examination.—Pain over the second metatarsal, which became worse on walking. The patient is in excellent health and gave no history of slip, strain, or accident.

X-ray Report.—The distal end of the shaft of the second metatarsal bone shows periosteal reaction perpendicularly to the shaft; there is some localized rarefaction. No history of trauma could be obtained. The appearances lend suspicion to a newgrowth (sarcoma).

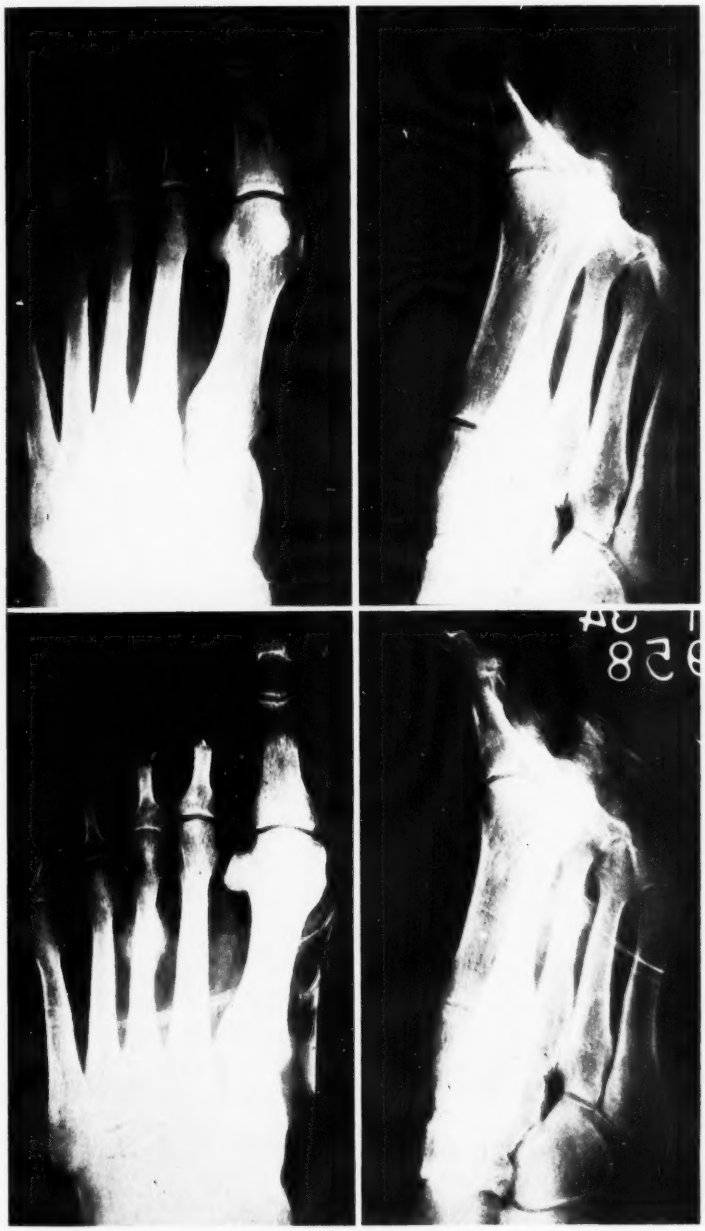
The following is an opinion submitted by a second radiologist: "This case is interesting and difficult; my opinion is that she has had an old united fracture, and is now developing a periosteal sarcoma over the old callus, which obscures the ordinary diagnostic appearance of a newgrowth. I must admit there is only a shred of evidence for this."

Operation.—Because of suspicious radiologic diagnosis of sarcoma, Lesfranc's amputation was advised. Macroscopic section showed hard dense bone. Microscopic section showed no signs of sarcoma. The diagnosis of rarefying osteitis with chronic inflammatory periostitis was established. Post-operative recovery was uneventful.

I cited this case simply because it was the means of saving a patient referred to me from a similar fate. The two cases re-

ported below were referred to me for roentgen examination.

Case 1. The patient, a white female, aged 45 years, a nurse by occupation, was



Figs. 1 and 1-*A* (*upper*). Roentgenograms made on Feb. 15, 1934, 10 days after onset of pain, showing irregular growth of periosteal new bone, about the shaft of the third metatarsal bone proximal to the head, and a fine linear fracture so insignificant that it might easily be overlooked.

Figs. 2 and 2-*A* (*lower*). Roentgenograms made on March 1, 1935, showing marked, spindle-shaped callus formation about the site of the fracture.

sent for x-ray examination because of a painful, swollen foot.

The pain and swelling were first noticed about ten days prior to admittance, and had been gradually increasing since, until the patient was unable to bear her weight on the foot.

Her past history was negative, except for a fracture of the astragalus about a year previously. There was no history of trauma.

Local examination revealed a swollen, edematous area on the dorsum of the foot. There was an area of localized tenderness on palpation over the shaft of the third metatarsal bone near the head. Tenderness could also be elicited on palpation of the head from the plantar side. There was a callosity on the plantar surface of the transverse arch. No other deformities were noted.

Roentgenograms (Figs. 1 and 1-*A*) made on date of first examination, Feb. 15, 1934, showed a linear fracture of the shaft of the third metatarsal bone about two centimeters proximal to the head. There is an area of increased density partly surrounding the site of fracture, resembling an irregular growth of periosteal new bone. This has the appearance of an incomplete fracture with early callus formation, or possibly a pathologic fracture with a beginning bone neoplasm.

The possibility of this being a newgrowth was at first strongly considered because of the absence of any history of trauma, but the subject of march foot was recalled, and after some debate the patient was treated by bed rest with immobilization of the foot in a light plaster cast.

Subsequent roentgenograms at intervals of two weeks (Figs. 2, 2-*A*, and 3) showed a marked increase in the callus formation about the site of the fracture. Recovery

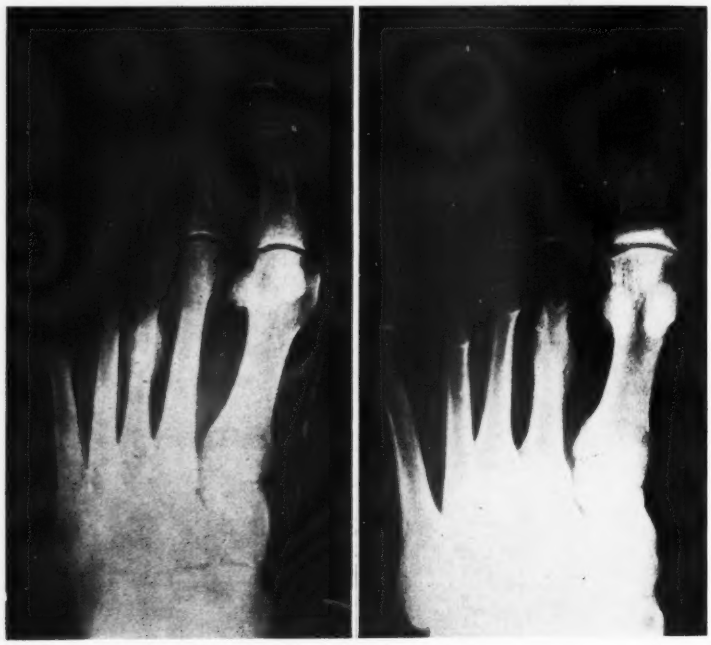


Fig. 3. Fig. 4.

Fig. 3. Roentgenogram made on March 16, 1935, showing definite increase in the density of the callus.

Fig. 4. Case 2. Roentgenogram showing typical spindle-shaped callus about the shaft of the second metatarsal bone, proximal to the head.

was uneventful and the tenderness about the palpable callus gradually disappeared until now the patient is free of pain.

Case 2. A white male laborer, aged 47 years, was sent for roentgen examination because of pain over the dorsum of the right foot and swelling which had developed about four months prior to examination. The point of tenderness was localized over the second metatarsal bone. There was no history of trauma.

Roentgen examination (Fig. 4) showed a definite spindle-shaped area of solid callus about the shaft of the second metatarsal bone, 2 cm. proximal to the head. This had the appearance of callus surrounding the site of an old fracture. Because of the history and roentgen findings, this was considered as a case of march foot. The possibility of an error in diagnosis in this case was avoided because of the lapse of time between the onset and the examination, with the resultant solid callus.

CONCLUSIONS

Recognition of the subject of march foot by the roentgenologist as a simple spontaneous fracture and not a bone malignancy, will prevent unnecessary mutilating and crippling operative interference in a comparatively simple condition which needs no further treatment than the immobilization of an ordinary linear fracture.

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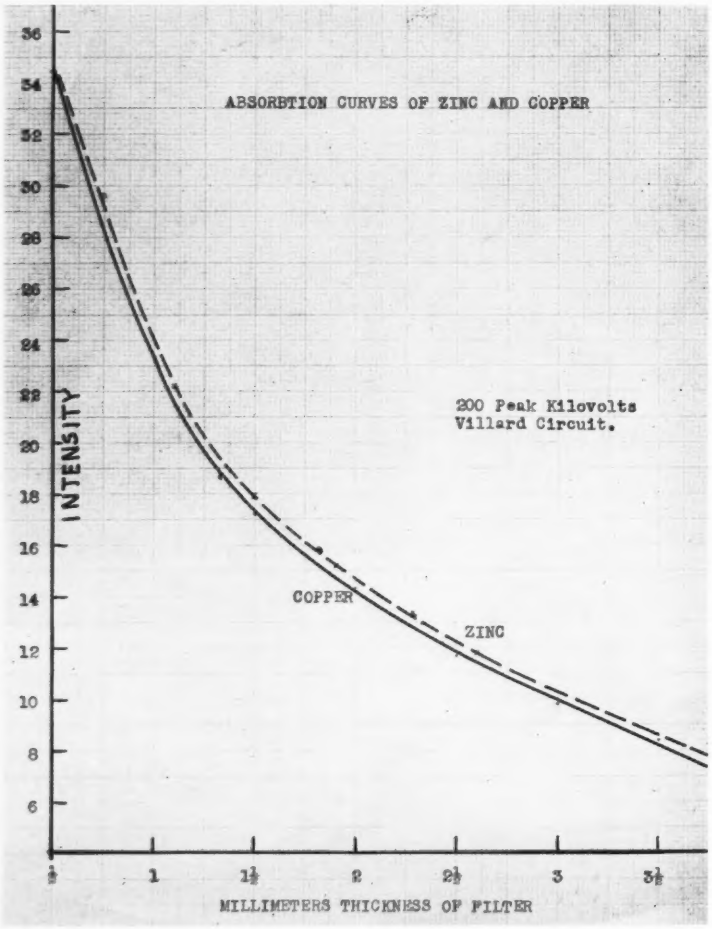
A NOTE ON ZINC FILTERS

By ROBERT S. LANDAUER, PH.D., *Highland Park, Ill.*

SINCE Dr. Coutard's recent visit to this country, there has been considerable interest aroused among radiologists regarding the use of zinc as a filtering material in 200 peak kilovolt therapy. Coutard uses zinc for part of his work, as do many of the German radiologists.

From theoretical considerations one would not expect to find any great difference in the relative efficiencies of the two metals as filters. However, it was deemed advisable to make actual measurements so that all doubt would be removed.

An x-ray machine of the Villard circuit was employed, operating at approximately 200 peak kilovolts. The intensity measurements were made with a Victoreen r meter.



Relative Intensities.—Figure 1 shows absorption curves for zinc and copper. It is evident from these curves that equal thicknesses of zinc and copper transmit approximately the same quantity of radiation.

RELATIVE QUALITIES

Effective Wave Length:

1.0 mm. Copper .....0.129 Å.
1.12 mm. Zinc .....0.125 Å.

2.0 mm. Copper.....0.111 Å.
1.9 mm. Zinc.....0.113 Å.

Note: Effective wave length determinations made with 1.0 mm. copper as auxiliary filter.

Half Value Layer:

1.0 mm. Copper.....1.45 mm. Copper
1.1 mm. Zinc.....1.55 mm. Copper
2.0 mm. Copper.....2.12 mm. Copper
1.9 mm. Zinc.....1.97 mm. Copper

CONCLUSION

No significant difference in radiation intensity or quality was detected in x-ray beams filtered with zinc and copper.

ROUTINE ROENTGEN EXAMINATIONS OF THE CHEST OF PATIENTS ADMITTED TO THE STATE OF WISCONSIN GENERAL HOSPITAL DURING A THREE MONTHS' PERIOD[1]

By ERNST A. POHLE, M.D., PH.D., Professor of Radiology, L. W. PAUL, M.D., Assistant Professor of Radiology, and W. H. OATWAY, JR., M.D., Assistant in Medicine, University of Wisconsin Medical School, *Madison, Wisconsin*

INTRODUCTION

ROENTGENOLOGIC examination of the chest is now commonly recognized as the most accurate method for detecting the early changes in most, if not all, intrathoracic diseases. The value of this method is perhaps best exemplified in the diagnosis of early pulmonary tuberculosis. For the past several years it has been the practice at the University of Wisconsin to take single roentgenograms of the chests of all freshmen students who showed a positive Mantoux tuberculin reaction. The results of these studies have shown us that many cases of early tuberculosis will have positive roentgen evidence before they can be detected clinically, and before the patients themselves are aware of any change in their physical status. It was felt that many patients admitted to the Wisconsin General Hospital might have significant intrathoracic disease, which would ordinarily remain undiagnosed because the patients, having no clinical evidence of such disease, would not be subjected to roentgenologic examination. In order to determine what this percentage was and the various diseases that might be discovered, it was decided to take routine roentgenograms of the chests of all patients admitted to the hospital during a three months' period. Our interest in this work was stimulated by a similar study undertaken at the University of Michigan. Patients in whom intrathoracic disease was suspected because of history or physical findings on first examination by the resident physician of the respective service were not included in this study, since these would have chest roentgenograms made during their complete clinical examination.

TABLE I.—TOTAL NUMBER OF ADMISSIONS AND PERCENTAGE OF CASES STUDIED

Month	No. of Admissions	No. of Chest Roentgenograms	Percentage
August	1,032	512	49.6
September	939	458	48.7
October	885	490	54.2
Total	2,856	1,460*	51.1

* Clinically analyzed and correlated, 1,417.

TABLE II.—AGE DISTRIBUTION IN OUR SERIES

Age	Percentage
0–10	14.7
10–20	19.6
20–30	14.0
30–40	13.8
40–50	14.2
50–60	11.1
60–70	7.5
70–80	4.5
80–90	.6

METHOD OF EXAMINATION

The method of examination consisted of a single roentgenogram taken in the usual manner. This was supplemented in some instances by roentgenoscopic examination and by additional films (stereoscopic, oblique, and lateral, as indicated). Table I indicates the number of admissions during this three months' period; thus it will be seen that 2,856 patients were admitted. Of these, 1,460 had routine chest films and these form the basis for this study. The remainder, or 1,396, either had clinical evidence of disease and their films were not included for study, or else

[1] Presented before the Radiological Society of North America, at the Twenty-first Annual Meeting, at Detroit, Dec. 2–6, 1935.

TABLE III.—CLASSIFICATION OF X-RAY FINDINGS

	No. of Diagnoses	Percentage
1. Negative	716	39.20
2. Bony lesions and abnormalities	1	.05
(*a*) Congenital anomalies	32	1.70
(*b*) Fractures—old and recent	13	.72
(*c*) Inflammatory lesions	2	.11
(*d*) Neoplasms (benign)	3	.17
(malignant, primary,	0	....
secondary)	0	....
3. Calcified cervical nodes	8	.44
4. Enlarged thyroid and substernal thyroid	17	.94
5. Cardiac disease	41	2.30
(*a*) Cardiac enlargement	178	9.82
(*b*) Aortitis (widened aorta)	194	10.69
(sclerotic plaque)	63	3.50
(*c*) Aneurysm	3	.17
(*d*) Congenital anomalies	6	.33
6. Mediastinal masses		....
(*a*) Lymphoblastoma	2	.11
(*b*) Hilum tuberculosis	0	....
(*c*) Enlarged thymus	13	.71
(*d*) Benign neoplasms	0	....
(*e*) Unclassified	3	.16
7. Tuberculosis		
(*a*) Primary (calcified in lung parenchyma)	192	10.60
(calcified in hilum nodes)	75	4.13
(active)	5	.30
(*b*) Adult (probably inactive)	29	1.60
(probably active, minimal)	9	.50
(mod. advanced)	0	....
(advanced)	0	....
8. Neoplasms		
(*a*) Primary (benign)	0	....
(malignant)	0	....
(*b*) Secondary	5	.30
9. Non-t. b. c. Inflammatory	1	.05
(*a*) Bronchiectasis	7	.39
(*b*) Lung abscess	0	....
(*c*) Chronic bronchitis	0	....
(*d*) Pneumonia	0	....
(*e*) Fibrosis	4	.22
10. Silicosis		
(*a*) First stage	2	.11
(*b*) Second stage	0	....
(*c*) Third stage	0	....
11. Lesions of the pleura		
(*a*) Apical cap	43	2.40
(*b*) Pleural thickening	7	.39
(*c*) Sero-fibrinous pleurisy	0	....
(*d*) Pleural effusion	5	.30
(*e*) Adhesions	74	4.10
12. Miscellaneous		
(*a*) Congestive lung	5	.30
(*b*) Anomalous lobes	9	.50
(*c*) Diaphragmatic abnormalities	4	.22
(*d*) Esophageal lesions	0	....
(*e*) Spinal abnormalities	29	1.60
(*f*) Spinal caries (cold abscess)	1	.05
(*g*) Emphysema	2	.11
(*h*) Subdiaphragmatic lesion	1	.05
(*i*) Pericardial calcif.	1	.05
13. Unclassified lesions	11	.61
Total	1,816	100.00

the patients were too ill to be subjected to examination. Undoubtedly a certain number were missed entirely, since it was left to the Resident Staff to make out the necessary requests for examination and to decide whether the patient should be placed in the "routine" or "necessary" group. Also a certain number of patients were placed in the routine group even though showing positive clinical signs either

TABLE IV.—CORRELATION OF CLINICAL AND SIGNIFICANT X-RAY FINDINGS

Diagnoses	No. of Cases	*Symptoms* Referable to X-ray Findings		*Physical Signs* Referable to X-ray Findings		X-ray Findings Undetected Clinically	
		+	−	+	−	No.	%
1. Rib (inflammatory lesions)	1		1		1	1	100
2. Ribs (neoplasms)	1		1		1	1	100
3. Thyroid (enl. and subst.)	14	12	2	11	3	2	14
4. Heart (enl.)	77	37	40	33	44	44	57
5. Heart (abnorm. silh.; no enl.)	31	11	20	10	21	19	61
6. Heart and aorta (enl.)	88	60	28	58	30	22	25
7. Aorta (wide, scler.)	118	64	54	60	58	47	40
8. Aorta (aneur.)	4	2	2	4		1	25
9. Med. masses	5	2	3	2	3	3	60
10. Thymus (enlarged)	9	1	8		9	9	100
11. Prim. T.B. (act.)	2		2		2	2	100
12. Adult T.B. (inact.)	28	8	20	2	26	23	82
13. Adult T.B. (act.)	4	1	3		4	4	100
14. Pulm. neopl.	4	3	1		4	3	75
15. Non-t.b. infl.	15	7	8	6	9	9	60
16. Silicosis	3	2	1		3	3	100
17. Pleur. effus.	3	3		2	1	0	0
18. Diaphr. abnorm.	6	5	1	6		0	0
19. Spinal deform.	28	21	7	21	7	6	21
20. Cold absc.	1	1		1		0	0

through error or, what was more likely, the examining physician considered that the findings were not significant enough to warrant x-ray examination. However, it is felt that the number of patients is sufficiently large to give some idea of the roentgenologic findings in the chests of patients admitted to a large general hospital which would, under ordinary circumstances, not be detected. Table II presents the age incidence of 1,417 patients according to decades.

All cases with positive x-ray findings were reported to the internist (Oatway), who then reviewed the clinical records. A record was made of the presence or absence of symptoms or physical signs which might have a connection with the abnormal x-ray findings. It was also recorded whether or not the staff had been aware of the condition during their examination and before the x-ray report was known. These findings were then correlated with the disease conditions.

RESULTS

In order to facilitate the recording of the x-ray findings a master list of diagnoses was arranged (Table III). The last column in this table expresses the percentage of findings rather than the percentage of cases, since the same patient may have had two or three different lesions. It is believed that this calculation gives a truer picture of the results obtained by the x-ray examination.

A number of the x-ray findings undoubtedly are without clinical significance, so that only the deviations from the normal with clinical significance were correlated with the completed clinical record as described above (Table IV). It appears that in a certain percentage of cases no symptoms or physical signs resulted from the abnormalities seen in the films. It was physically impossible to conduct a special follow-up examination directed toward clinical verification of the x-ray findings. In evaluating the merits of the method, the x-ray findings are therefore taken at face value. On the other hand, we tried to credit the clinician fully with the results of the clinical examinations.

In Table V the age incidence of the aortic lesions for 179 cases is given, while Table VI offers an evaluation of the procedure. It appears that 7 per cent of all admitted patients showed lesions on x-ray examination undetected clinically, while

this percentage increases to 13.3 per cent if calculated in relation to the number of cases x-rayed routinely. (See under "Discussion").

DISCUSSION

In analyzing the results of this study we must bear in mind that it was undertaken primarily in order to decide whether or not the procedure followed should become one of the routine methods of examination for all admitted cases. A study of Table IV reveals that among the 20 selected groups representing clinically significant lesions there are some which require clinical correlation, not only to ascertain the diagnosis but also to determine the importance of the roentgenologically suspected lesion to the individual patient. This holds particularly true of heart disease in its early stage. A slight enlargement of the heart may easily be overlooked on physical examination, while a thorough search following the detection of beginning changes by the roentgen examination might prove invaluable to the patient. On the other hand, we fully appreciate the fact that a single film does not constitute a complete x-ray examination of the heart. We leave open, of course, the question of whether or not the lung lesions considered as active tuberculosis are really active in the clinical sense; likewise we do not wish to deny the possible clinical importance of roentgenologically inactive processes. However, we feel that it is essential to know that such changes are present and must be followed clinically and roentgenologically. If we omit all groups in Table IV in which the accuracy or importance of the x-ray diagnosis may be questioned for any reason, this leaves Groups 1, 2, 8, 9, 11, 12, 13, 14, 16, 17, and 20 to be regarded as significant in the final evaluation of the procedure. Deducting, therefore, all other groups, this still leaves 41 cases with significant lesions detected by the single-film method, and in which the diagnosis could be established by three observers with such a degree of probability as to accept it for statistical evaluation. On that basis it appears that 2.9 per cent should, in our opinion, be considered as the figure expressing the true value of our method.

TABLE V.—AGE OF 179 PATIENTS WITH AORTIC LESIONS

Age	Percentage of 179 Cases
Under 40	3.9
40–44	6.2
45–49	7.3
50–59	32.3
60–69	27.3
70–79	20.1
Above 80	2.9

Average age of patient with aortic changes, 59.4 years.
Average age of patient with normal chest, 34.5 years.

TABLE VI.—EVALUATION OF PROCEDURE

Total number of routine studies over a three months' period	1,460
Clinically analyzed and correlated	1,417
Important x-ray findings undetected clinically	199

Percentage, approximately 13.3%.

The question arises now whether or not to recommend this routine x-ray examination of the chest in the case of all patients admitted to a hospital. This is undoubtedly a combined medical-economical problem, and we personally decline to enter into the financial side of the picture, which is an important factor in deciding the question: human health or life cannot be expressed in monetary values. The problem must, perhaps, be answered by the individual hospital organization concerned, and before reaching a definite conclusion we would like to see similar studies conducted in other institutions in order to obtain further data for comparison. There is no doubt in our minds but that the routine roentgen examination by the single-film method of all patients admitted to a hospital is of definite clinical value.

SUMMARY AND CONCLUSIONS

(1) During a three months' period single chest roentgenograms were taken of all patients admitted to the State of Wisconsin General Hospital, who would not have had such an examination made under ordinary circumstances.

(2) A total of 2,856 cases were admitted; 1,460 routine chest films were taken; in 1,417 cases the x-ray and clinical findings were correlated.

(3) An evaluation of the procedure showed that 13.3 per cent of all cases studied by this routine x-ray examination had significant lesions undetected clinically; eliminating all cases of debatable importance, *e.g.*, configuration of the heart silhouette and enlargement of the thymus, this still leaves 2.9 per cent of significant lesions without clinical symptoms or signs.

(4) The general value of this method of examination is briefly discussed.

SOME LAWSUITS I HAVE MET AND SOME OF THE LESSONS TO BE LEARNED FROM THEM[1]

(*Eighth Installment*)

By I. S. TROSTLER, M.D., F.A.C.R., F.A.C.P., *Chicago*

A PRURITUS AND ECZEMA CASE: NOT INSURED

ONE of the old-timers and a man of wide and varied experience and high professional standing wrote me under date of May 27, 1932, as follows: "Last Fall—in November—I wrote you regarding a threatened malpractice suit—or rather a blackmail scheme. Well, on Monday of this week they served papers. I will give you the history.

"May 21, 1931, a little dark man came to my office, sent by a doctor, for x-ray treatment. He had a history of *pruritus ani* and dermatitis of long standing. He had dug himself with his fingernails until he had a raw, irritated surface. I told him that I would give a fractional dose to possibly soothe the area.

"I gave 65 kv.p., 2 ma., 3 minutes, 12-inch distance, 1 mm. Al filter, through a lead cone 2 inches in diameter. What part of a skin unit would you call this?

"He claims that on the third day he had a burning sensation, 3 inches above the anus, 6 inches down the legs, 5 inches wide, front and back of scrotum, etc., and that on the fourth day that area was bright red like a severe burn. He said that that area all peeled off and was healed by July 15, but owing to the tenderness of his skin he was unable to work until Nov. 1, 1931. He also claims to have been made impotent.

"Before and after the one treatment he was using an ichthyol and resorcin ointment, but used none on the day of the treatment.

"Will you be kind enough to write me what you think of this case? Also, any advice you can give will be appreciated."

On May 31, 1932, I wrote him: "Yours of the 27th received and I hasten to reply. I would say that your 65 kv.p., 2 ma., 3 min., 12-inch F.S.D., with 1 mm. Al filter would produce approximately not to exceed 1/16 E.S.D.

"While I seldom use a lower kilovoltage than 85 p.kv., upon looking up what MacKee has to say about lower voltage, which you know the dermatologists use, I found on pages 258 and 259 of MacKee's 1927 (2nd) edition that Charts 17 and 18 show that at 64 kilovolts, 12-inch F.S.D., 2 ma., the dosage without filter is given as 16 minutes and 40 seconds for an E.S.D. Now as the addition of 1 mm. of aluminium filter will allow the administration of triple the unfiltered dose at this same setting, we may safely say that the dosage (with 1 mm. Al filter) is 50 minutes. You administered 3 minutes, or less than one-sixteenth of the dose.

"However, the fact that your man was using ichthyol and resorcin might—and in all likelihood would—make a considerable difference in the effect of your dosage: but almost surely not enough to make his injury any more than a very slight one. The fact that he claimed that on the third day he had the burning sensation, on the *front* and back of his scrotum (when, as I understand it, your treatment was applied only to his perineum and through a lead cone with a two-inch aperture), indicates to me that he is out to get some of your money, more than for damages for a real injury.

"As regards the claim for you having rendered him impotent, that is ridiculous, because he did not receive enough to affect his testicular function, except for the very evanescent effect of the suppression of the spermatozoa, and that for only a few days, if at all. In my opinion, his allegation *re* your rendering him impotent

[1] The Editor desires to state that much of the matter herein has to be printed in form as received, without normal punctuation or phrasing.

is that it is just a plain lie. Impotency is not a part of the effect of x-ray therapy. Sterility is, but he would not know anything about that. This to me indicates that your man is merely trying to hold you up.

"I am sending you herewith a questionnaire for you to fill out, so that I may have the full particulars. Send this to me, and in the meantime I do not believe that I would worry much about that lawsuit."

A few days later this roentgenologist wrote: "Thank you for your prompt reply. My suit has been put off until September. I will fill out the questionnaire later and send it to you.

"My standing here is good and I have, as far as I know, the entire medical profession behind me—at least the representative surgeons and doctors. I am vice-president and on the Board of Governors of St. A. Hospital and the entire staff are for me. One of this staff sent the man to me for treatment and saw him before and after the treatment. He says the patient is a neurotic and scratched himself until he was raw, so that it took until July 15, 1931, before he was healed.

"This is my first experience with malpractice suits . . . and feel extremely fortunate that I have some one like you who has had experience with them to tell me what to do. In the meantime, any suggestions you have to offer will be gladly received."

On June 27, 1932, I wrote: "Yours with filled-out questionnaire received and noted.

"Analyzing the case of M— *vs.* H— from the information in my hands, I would say that the technic you used would produce less than one-sixteenth of a skin unit (E.S.D.). Even if the filter was left out it would produce only about 22 per cent of one E.S.D. With that knowledge, you may feel sure that you did not damage this man, no matter what he says, and you can get plenty of expert testimony to controvert his testimony.

"As just stated, you will have no difficulty in securing plenty of the best of expert testimony that your technic was correct, that the technic applied will not injure a normal or diseased skin, that the x-rays as so applied is proper and approved treatment for *pruritus ani* and eczema.

"In the event that this man does not secure a physician who will testify that your technic was wrong, that your treatment was wrong, that you were negligent, that you did something that you should not have done, or, in other words, that your handling of the case was malpractice, your attorneys should have no difficulty in inducing the trial judge to take the case from the jury, because plaintiff has presented 'No case.'

"If, however, plaintiff is able to secure expert testimony that you were wrong or negligent in any important particular and that it was malpractice, as I just indicated, it would be most advisable that you prove *by a preponderance of the evidence* that you were not guilty. For that reason, I advise you to be prepared to have one or more expert witnesses in addition to Dr. B., whom I am sure will be very good.

"Among the men from that region, I would suggest Dr. Q— of P., X— of D., L— of S., L— of C., C—, S—, or T— of S., F— or V— of M. B. The latter would be a particularly valuable man. I am reasonably sure that any of these men would be willing to come if their expenses are paid.

"I note that you said, 'had used ichthyol ointment.' Did you prescribe that or was it prescribed by Dr. X—? Or did the patient (plaintiff) apply that ointment without any physician's orders? If the latter is true, and the case goes to the jury, it may be advisable to use this fact as a basis for alleging contributory negligence (one must keep in mind that every possible chance and every little kink and quirk must be utilized to win these cases).

"It is certainly unfortunate that you do not carry insurance against this sort of thing. I have for many years been a strong advocate of insurance, and advise every physician to carry malpractice insurance.

"I am writing all this, so that you can

get my 'slant' on how to handle the case and be thereby better able to ask me questions about it.

"Regarding attorneys there: I. and X. have defended malpractice suits successfully; *but they have also prosecuted them.* E. and E. have very successfully defended malpractice suits, and N. and N. are considered to be high-class attorneys. You, of course, know more about those attorneys than I can find out from this distance, but I thought that I would give you what information I could learn about them.

"Trusting that this finds things shaping up for a victory over that rascally easy-money-getter, I am—"

In a recent letter Dr. H— wrote: "My malpractice suit (which was really a blackmail scheme) was settled for $300. Just think—a $20,000 suit settled for $300. It would have cost me even $1000 to go into court with it."

This is another example of why we have to pay such high rates for our malpractice insurance. An insurance agent recently informed me that good attorneys—in the State where the foregoing occurred—would not accept a case for less than $500 retainer fee to start with.

WAS HE DUMB? OR WAS HE DUMB?

A manufacturer of x-ray apparatus received the following letter from a dentist in a north-central State. (Grammar, punctuation, and spelling exactly as in the original.)

"X. X. X.....Co., Inc.,
Chicago,
"dear sir:

I have been informed that I have a suit filed against me in this county for the recovery of $32,000.00 due to damages received from a supposed x-ray burn.

"I am using an x-ray of your make in the cabinet style No. 5004. This patient was refered to me by a physician to ascertain the extent of an injury to the wrist. I examined the wrist under a smal florescope and some time later which was about one week there appeared a blister so I am told on the back of the wrist. In the meantime the patient had returned to the MD. for sprain treatment. Then at a later date there appeared a sore of some sort on the other side of the wrist and did not respond to treatment by his local MD. due to infection. The local MD. tried a skin graft which did not work but the place became worse under his course of treatment and by the time he reffered the patient to another MD. The place was in very bad shape. They placed him in a hospital and after getting the underlying tissue in shape they grafted and it has worked.

"This was about one year ago. Now just how long can a place be exposed carrying a 10 millamp load without injury? I really believe that the case will be stopped but I am not certain. It will be expensive for him to sue and due to the fact that judgment is all they will be able to get I hardly believe they will go thru with the deal.

"It is my information that you carry insurance on each machine in operation. This being a fact I will contest his claim which would cost a little money and I am quite sure of beating the case but it might be settled a little cheaper out of court. Your name has not been mentioned as yet although they did get the number, etc. of the machine. You will undoubtedly hear from them some time. If you are carrying insurance and since the case is yet young and you are not mentioned it might be your pleasure to call a halt, I am quite sure I can get a good settlement.

"You undoubtedly have some of the proceedings of such cases in other courts which would be very valuable to me and which I would appreciate receiving. I have not talked to a lawyer as yet and will not until I hear from you. Kindly answer at once. Yours very truly,

F. I. L....."

It seems hardly possible that a man, least of all a dentist, and member of one of the so-called learned professions in the year of 1931 could be so stupid as to write such a senseless and vapid letter as the foregoing; but it was really done. It was

not written as a joke, but the poor clown actually thought that the manufacturer was going to rush a defense for his egregiously erroneous practice, and continue to defend the users of their apparatus as long as they were in use. It would be fine if the manufacturers would do that, would it not?

RES IPSA LOQUITUR

While this is not one of the "Lawsuits I have Met," so many cases have hinged and been swung on the maxim of *res ipsa loquitur*, and so much attention is being paid and has been paid to the celebrated decision of the late William Howard Taft, in which this maxim and its application to medical malpractice suits are strongly stressed, that it seems to me a recital of and quotation from the very famous decision in the case of Ewing *vs.* Goode[2] is fitting and apropos.

The plaintiff in this celebrated case had a cataract in her right eye and consulted the defendant, an ophthalmologist. She subsequently developed glaucoma which necessitated operative removal of the eye ball, and, of course, loss of sight in that optic. Later her left eye became affected and the sight therein was partially lost.

In the suit for malpractice the claim was made that the maxim of *res ipsa loquitur* (the thing speaks for itself) should apply, alleging that the fact that the condition of the plaintiff's eyes and her loss of sight should be sufficient to prove malpractice. Because of their reliance upon this, no expert testimony was introduced that the lack of skill and/or negligence caused the injury.

Mr. Taft, sitting at that time as a judge of the United States Circuit Court in Ohio, directed that a verdict in favor of the defendant be brought in by the jury. He said in part: "Before the plaintiff can recover she must show by affirmative evidence, first that defendant's want of skill or care caused injury to the plaintiff.

"If either element is lacking in her proof she has presented no case for the consideration of the jury. The naked facts that defendant performed an operation on her eye, that she had pain and that subsequently the eye was in such bad condition that it had to be extracted, established neither the neglect nor the unskillfulness of the treatment nor the causal connection between it and the unfortunate outcome.

"It is not enough to show that the injury, together with the expert opinion that it might have occurred from negligence and other causes. Such evidence has no tendency to prove that negligence did cause the injury. When a plaintiff produces evidence that is consistent with an hypothesis that the defendant is not negligent and also with one that his proof tends to establish neither.[3]

"A physician is not a warrantor of cures. If the maxim of *res ipsa loquitur* were applicable to a case like this and a failure to cure were held to be evidence, however slight, of negligence or unskillfulness on the part of a physician or surgeon causing a bad result, few could be found who would be courageous enough to practise the healing art, for they would have to assume financial liability for nearly all the ills that flesh is heir to."

Further comment or explanation at my hands would be superfluous and presumptuous, except that I am glad to be able to report that the courts appear to be coming more and more to the opinion that the maxim of *res ipsa loquitur* should not apply in medical malpractice cases, and that the malpractice complained of must be proven by expert testimony.

PHYSICIAN CHARGED WITH PERJURY, BUT WE STOPPED THE PROSECUTION

Several years ago my attention was called to a case in the United States District Court in Chicago, wherein a physician was charged with perjury because of his stating in an affidavit that, in his opinion, a certain roentgenogram of a thorax indicated chronic tuberculosis.

Being considerably interested, I investigated the matter and found that the physician had been appearing rather often in damage suits, and in the case in which he

[2] 23 Fed. R., 442.

[3] An exact quotation.

was charged with perjury, he had examined an ex-service man who was trying to secure an increase in his disability allowance from the government.

The regular examining board had reported unfavorably upon the application and had advised against the increase. The ex-soldier had been sent to the physician, who after making physical and roentgen examinations, sent his affidavit and report stating that the applicant had a chronic tuberculous process in his lungs. This affidavit in the natural order of things came to the notice of the examining board, and they, mainly because of the unsavory reputation of the physician as a witness, induced one of the Assistant United States District Attorneys to proffer the perjury charge against the physician.

Recognizing the potential danger in permitting *any* physician to be prosecuted for perjury because he rendered an opinion, I got in touch with this physician and asked him to bring the roentgenogram in question to my office. This he did, and upon examining it, I found it to be a very dense film that had been overexposed and overdeveloped, but which, upon being placed before a very intense light (I used a photo flood light), disclosed ample evidence of chronic fibroid tuberculosis with cavitation, for any experienced roentgenologist to make such a diagnosis.

Pursuant to my advice, the doctor left the film with me and I had two well-known and experienced roentgenologists see it. Both of these agreed with my diagnosis and consented to testify to those findings if necessary.

I then suggested to the physician that he inform the Assistant District Attorney in charge of the case that Drs. — and — and I were going to testify that his findings were correct and to suggest that he get in touch with me. This was done and the attorney sent an investigator to interview me, with the result that the charge of perjury was publicly withdrawn.

While I held no brief for the physician who was charged with perjury, and do not always agree with his testimony, the risk and danger of allowing *any* medical man to be tried for perjury because of his rendering an opinion upon any medical subject, was far too great for me to allow to pass unchallenged. The potentiality for abuse or misuse of a decision, coming as it would in this instance from a United States District Court, might establish a precedent that might bode no good for expert witnesses everywhere. It might open a way, a means of procedure, whereby any of us might be charged—even if not convicted—with perjury if we differed in opinion with any other man. This might be particularly true if the other man had any considerable political "drag" or "pull."

HE OPERATED ON THE WRONG PATIENT

About twenty years ago two physicians, friends of the writer, delivered boy babies the same day in a hospital, and according to previous arrangement were to have circumcised the babies. A few days later Dr. L— circumcised a boy, supposing it was his patient, and when Dr. M— appeared later in the day and made ready to operate on his little patient, he was somewhat nonplussed to find the job already done.

As the children's department adjoined the roentgen department, Dr. M— drifted into my sanctum and asked me what he should do.

We reached the other physician by telephone in a few minutes, and Dr. M— asked what in H— he meant by circumcising his patient, with the result that Dr. L— came to the hospital post-haste, and, of course, had to operate on his own baby patient.

The parents of these two boys never learned the particulars of the affair, and as the physician who operated on both boys has passed to his reward in the Great Beyond I feel free to relate the incident.

While the foregoing did not cause any legal difficulty, the potentiality of such a thing is so great that we cannot help but remark upon it.

I have known of patients having the wrong eye and the wrong foot operated

upon, and this instance in which the wrong patient was operated upon, beside more than a few instances in which the wrong tooth was extracted. Such cases as these are fortunately very rare and, of course, speak for negligence when they do occur; but even then, in most States, the parties concerned would have to prove by expert testimony that it was negligence. Of course, it would not be difficult to prove that.

I ANSWERED HIS QUESTION

In a personal injury suit in Chicago a couple of years ago, I was called to testify as an expert and after interpreting several roentgenograms of a wrist and hand, which I found to be normal, although the plaintiff alleged and the bill of particulars described several bone injuries, I was subjected to a grilling cross-examination.

The attorney for the plaintiff evidently made every possible effort to break down the effect of my testimony, intimating that I was called by the insurance company regularly and frequently, that I always appeared for corporations, questioned me about my fee and the various irritating things that lawyers know so well how to do, in an effort to get me off balance and angry; but he soon discovered he could not get far. After asking me if I was familiar with the latest development in medicine, and other similar idle questions, he asked:

Q. "Dr. Trostler, I presume that you are familiar with the philosophy and application effects of homogeneous and heterogeneous evolution as it affects medicine and surgery." To this I made no reply.

Q. "Why do you not answer my question, Doctor?"

A. "You did not ask a question, Mr. T—. You made a statement that you presumed certain things."

Q. "All right, I ask you, are you familiar with the philosophy and application effects of homogeneous and heterogeneous evolution as it affects medicine and surgery?"

A. "I have heard of it."

Q. "Do you know or believe that the internal organs of the human body reason deductively or inductively?"

A. "I believe that the conglomeration of the hypothenuse imperceptibly transubstantiates the perspicuity."

Q. "What do you mean by that?"

A. "Exactly what I said. Shall I repeat it?"

The Judge: "It sounds to me like a lot of highfaluting nonsense."

A. "That is precisely what it is, Your Honor; but it is not quite as nonsensical as was the question Mr. T— asked me about the 'internal organs reasoning deductively or inductively.'"

Mr. T—: "I object, and move that the last remark of the witness be stricken from the record."

The Judge: "Objection sustained and motion granted. It will be stricken."

Q. "Now, Doctor, I renew my question."

A. "And I renew my answer."

Q. "Can you not answer the question?"

A. "Your question is meaningless and unanswerable."

Q. "That is your opinion?"

A. "It is."

I was then excused and left the witness stand. The subject of the "philosophy and application effects of homogeneous and heterogeneous evolution as it affects medicine and surgery" *was not again mentioned in the case.* Obviously, that Smart Alec attorney concluded that his effort to trap me was "not so good," or "sumpin."

REFORMS IN MEDICAL TESTIMONY

While not strictly a "lawsuit I have met," the following is so closely akin thereto that the writer feels that it should be included among this category.

A very well and favorably known radiologist in a central State wrote me a few years ago asking about my opinion regarding some "reforms in medical expert testimony." My reply was, in part: "Yours of several weeks ago . . . . . and I have just reached a place where I can

concentrate enough to reply, in a semi-intelligent manner.

"'Reforms in medical expert testimony' are indeed very much needed; but I feel that I can offer little that is worth more than a passing thought as to how this great desideratum may be accomplished.

"While I have given this subject considerable thought, I have written nothing upon it up to this time. I certainly do not agree with Stryker *re* the commission plan. In fact, it seems to me that the commission plan is the only one that apparently offers any practical and equitable solution to the problem. If each side to a suit would choose one or more experts and have these jointly examine the plaintiff in the presence of one or more (*all other*) experts in the case, *with the presence of an officially sworn court reporter whose duty it is to report all proceedings of the examinations and furnish copies of the transcript thereof to the attorneys for both sides of the suit and to the court*, the experts for both sides of the suit would have equal knowledge of the findings, and would consequently have the same opportunity and be enabled to render proper and correct opinions. The reporter's transcript would enable the attorneys to plan and frame questions which would bring out the truth, or at least much nearer to the truth than would be obtainable by any of the present methods.

"A modification of this plan, wherein the court might appoint one or more experts who might take part in the above-outlined procedure and either advise with the court as *amicus curæ* or testify in the trial of the case, would, it seems to me, to be pretty near ideal.

"A few years ago, I used to be called at more or less frequent intervals as an expert witness in personal injury cases, by one of the largest corporations in this city. Because I insisted upon telling the truth exactly as I saw it, I never became very popular with their attorneys and I was finally told by one of these, that they were 'sorry we cannot use you oftener, Dr. Trostler, because we like your convincing way upon the jury; but you do not seem to see things as we want you to see them.' Nowadays, most of the men who are doing much court work as expert witnesses have to see things as the lawyers want them to. They have to be equipped with unvulcanized rubber consciences, with little sulphur added. However, I am sure that they will get their full supply of sulphur in the hereafter.

"It must be admitted that expert medical testimony (as now used and given), which should be a valuable aid and important method in assisting in the administration of justice, has degenerated into anything except what it should be, in the great majority of instances of its use. In my opinion, it has become almost a laughable joke in criminal cases, where a group of alienists examine criminals for their sanity and responsibility. In civil suits involving personal injury, it is but little better, while in will cases, where there is a question of the sanity of the testator, you can buy almost any sort of opinion you want.

"In personal injury suits, it has become almost a fact that the side which can employ the most bumptious, self-assertive and presumptuous expert witnesses almost always registers the greatest amount of testimony and consequently wins the argument and the verdict.

"Getting somewhat away from the subject of your query, I find that there are quite a few things in Stryker's valuable little book, 'Courts and Doctors,' with which I do not agree, even though I lauded it highly in my review of it in RADIOLOGY. One of these is the first sentence of the paragraph beginning near the middle of page 83.[3] Here it appears that the author shows that it is as unwise for a lawyer to discuss medicine as it is for a physician to discuss law. While he doubtless means well by making that statement, you and I and every other well

[3] The sentence mentioned reads: "X-ray therapy differs from radiography in this, that in therapy there will needs be an occasional burning of the intermediate tissues in order that the rays may penetrate to the deep-seated point of the disease."

informed radiotherapist knows that he is wrong in his assumption."

Since writing the foregoing letter to our good colleague, the subject of reforms in expert medical testimony has been brought up by other, and by far better informed men than the writer; but as "Fools venture where wise men fear to tread," I prepared a paper for presentation before our local Roentgen Society (published in the May, 1935, issue of this Journal). It brought more favorable and complimentary letters than any of the (over 130) papers that the writer has published. Some twenty attorneys, to whom the writer sent reprints, commented favorably upon it, which, in the language of the street, is "going some."

MASTITIS NEONATORUM AND IMPETIGO CONTAGIOSA: ULTRA-VIOLET LIGHT

Recently, a firm of attorneys sent a child and his mother to me for examination and that I might report relative to the former's condition; also, my opinion as to whether his present condition was caused by negligent or improper treatment by his physician, or to what it might be due.

The history of the child's case, as given me by his mother, was briefly as follows: A few days after his birth in a hospital the boy developed a marked *mastitis neonatorum*. Almost at the same time, he developed an impetigo (probably *impetigo contagiosa*) which soon invaded the already involved left breast.

Naturally, the child became quite ill, but due to decidedly good treatment fully recovered and was at the time I saw him a husky, rugged lad of eight, with numerous scars on his neck, chest, abdomen, and legs.

The mother insisted that the physician who had taken care of her at the time the boy was born had overdosed the boy with some sort of drug which had made him susceptible to the disease he developed as above described, and that later he had burned the boy by applying "ultra-*violent*" rays, the latter being the cause and reason for the numerous scars on the boy's neck, body, and legs.

After complete physical and roentgen examinations of some of the boy's bones and joints, I reported to the law firm as follows: "I have made exhaustive examinations of your client, little Philip E. J—, the eight-year-old son of Philip J—, of . . . . Avenue, this city, and have elicited the history of the boy and his illness from his mother and hereby tender you my report and opinion as requested by your Mr.—

"The boy shows numerous scars in the neck, a very definite scar with absence of the glandular and considerable muscle tissue in the region of the left breast, and adjoining region downward and toward the left side. There are also numerous variously sized scars on the right side of his thorax, the anterior and right side of his abdomen, and on both thighs and buttocks.

"There is also definite evidence of a low-grade rachitis, which in common parlance is rickets, as evidenced by slight parietal bosses on his head and enlargement of the knee joints, and verified by roentgenograms of his knees and shoulders. A series of small knobs on the anterior ends of his ribs, which is frequently called a rachitic rosary, is also present. His teeth also indicate a diminishment of calcification.

"Accompanied by a history of an early *mastitis neonatorum*, or early inflammation of the breast, and a severe impetigo in his early infancy, it is clearly and easily conceivable—and in my opinion certain—that *all of the scarring* upon his neck, body, and limbs may be blamed upon and are due to the mastitis and the impetigo. It is equally evident—and to me certain—that the inflammation of his breast, the impetigo, or the resultant scarring, or the rachitis cannot possibly or by any stretch of imagination be blamed to the physician who attended him during the period of these illnesses.

"Mrs. J— stated to me that several "*ultra-violent*" light treatments were given to the baby, from a big "*Albion* Sun" (she undoubtedly meant *ultra-violet light* from an *Alpine Sun* lamp). Ultra-violet light

is very efficient and an approved method of treatment for impetigo at any stage of the disease and certainly had no direct or indirect connection with the scarring present on this child, even if there had been overdosage of the ultra-violet light administered. I say this with a knowledge of the effects of overdosage of this form of light, knowing as I do that it does not penetrate deeper than the superficial or outer layers of the skin, producing a dermatitis which disappears after the effects wear off and the tanning or pigmentation fades out, exactly as does a severe sunburn. No scarring or permanent effect is left to indicate that such a process has ever been present. I am sure that the physician who administered this treatment can produce any number of competent expert witnesses who will testify that the foregoing is true, and I am equally sure that you will be unable to secure qualified expert witnesses to testify that the foregoing is not true.

"Summing the matter up and speaking from experience of over thirty years in the handling of this sort of condition, I am sure that, firstly; the scarring upon the body, etc., of the boy is the result of a disease, for which the attending physician cannot be held responsible: secondly, the treatment as administered by the attending physician was proper and approved according to modern standards and methods of treating impetigo: thirdly, that the ultra-violet light, even if administered in a dose larger than normal or larger than was necessary, would not and could not have been the cause nor have contributed to the increase of the scarring in any way, and finally, not only will the attending physician be able to secure an abundance of expert testimony that his treatment was correct and that he was not guilty of malpractice, but you will in all likelihood be unable to secure any reputable physician or other witness who can qualify as an expert to testify that any wrongful act, negligence, ignorance or other malpractice has occurred in the handling of this case.

"I doubt if you will like the tone of and contents of this report, but you do not want me to inform you wrongly and lead you into filing a suit which will not be of any use or value to your or your clients," etc.

Evidently, the law firm did not place great reliance or confidence in what I said in my report, because they started suit against the attending physician, in behalf of the boy. At the trial, several physicians testified that *mastitis neonatorum* was a frequent disease, that impetigo was likewise common in infants, that the scarring on the boy's body was the result of the disease, that ultra-violet light was an approved treatment for impetigo, that overdosage by the light had not been given according to the records of the defendant physician, that overdosage of ultra-violet light does not produce lasting scarring, and that all the scars on the boy were the result of the impetigo and the *mastitis neonatorum*.

After the plaintiff's attorneys had introduced all their evidence the attorneys for the defendant asked the court for a "nonsuit" because, they alleged, the plaintiff's attorneys had not proven any malpractice. The judge said that even he, who had no medical knowledge, could see that the scars on the boy were not the results of burns. He took the case from the jury and gave a verdict for the defendant.

Conversation with one of the firm of three attorneys a few days later elicited the information that two of them had favored not starting suit, but that the senior member of the firm insisted upon suit being filed, and that the junior members of the firm were chuckling over the outcome, because they had been the ones who had referred the boy to me for examination.

FINGER PRINT EVIDENCE TO IDENTIFY A FORMER PATIENT

About ten years ago a 35-year-old man, who was injured while alighting from a street car in an adjoining city and had had a casual examination by a local physician was referred to me by his family physician

for roentgen examination of his right leg and ankle.

I found a fracture of the right fibula about four inches proximal to the distal extremity, and—more as a lark than for the purpose of identification—I had him make thumb and finger prints of his right hand upon the back of my record card.

About a year later, I was called as a witness to attend the trial of the injured man's suit for damages against the railway company. After being qualified, presenting my film, and interpreting it, I was asked if I would know the man I had examined if I saw him. I stated that I would not know the man but that I could identify him. The attorney for the defendant railway company immediately asked that my answer be stricken from the record, whereupon the judge asked me how I could identify the man if I did not know him when I saw him. When I blandly replied, "By his finger prints, Your Honor," the plaintiff showed by a broad grin on his face that he remembered the incident, and there was quite a stir in the court room. A rubber stamp pad was sent for and the plaintiff was caused to make thumb and finger prints as I had previously done, and I was able to positively identify him as the man whom I had examined and was testifying about.

While I do not advocate the making of finger prints as a routine, in connection with our work as radiologists, this instance, showing the great value and utility of the procedure, has caused me to use it on several occasions where certain identification might be necessary, though none of these has ever been used except the one just related, when it was done more as a lark than for any purpose.

A FEE CASE

A well known and celebrated otolaryngologist, while caring for a wealthy patient who was afflicted with a laryngeal cancer, was called to this patient's bedside at three o'clock one morning. While there, he found it necessary to perform a tracheotomy permitting his erstwhile suffocating patient to survive several weeks, make a will, and "put his house in order."

After the patient's death, the otolaryngologist rendered his bill to the administrator of the estate, including among other items a charge of $2,500 for the emergency tracheotomy. The administrator refused to pay that portion of the bill, so the Doctor brought suit for it. The trial of the case was before a judge only, by agreement, and I appeared as an expert on medical fees, because I had recently been the chairman of a committee which had drafted a new fee schedule for the Chicago Medical Society, the same having been adopted and then in force.

After duly qualifying, I was asked what, in my opinion, would be "a fair and just fee for an operation upon the trachea, upon a man worth a million dollars, who was suffering so that he was unable to catch his breath, in fact suffocating, the operation being done at about three o'clock in the morning, at the home of the patient, and resulting in the patient living in comparative comfort for a matter of two or three weeks." I replied, "From $2,500 to $3,000." That was the only question, outside of those regarding my qualifications as an expert.

The judge before whom the case was tried gave the otolaryngologist a verdict for $2,500 and costs. Your relator did not get so much as a "Thank you" from the Doctor. Of course, I was "only a roentgenologist."

(*To be continued*)

CASE REPORTS AND NEW DEVICES

REPORT OF A CASE OF HORSESHOE KIDNEY

By L. K. EMENHISER[1], M.D., *Oklahoma City, Okla., and* J. C. KING, M.D., *Memphis, Tenn.*

This report is being made because it affords material for a review of the roentgenologic and anatomic findings in a case of horseshoe kidney, and not because it presents anything new or extraordinary.

The specimen in question was discovered during routine dissection in the gross anatomy laboratory of the University of Tennessee Medical School. After a careful removal of the anatomic parts, a pyelo-ureterogram was made, using iodized oil, which afforded an opportunity for study of the kidney pelves and ureters without destruction of the specimen. It has been our experience that, by close co-operation of the departments of roentgenology, anatomy, and pathology, valuable information may be obtained from postmortem examinations with the roentgen ray, in a manner similar to that used in the living. One may thus accurately correlate the roentgen findings with the pathologic changes.

Fig. 1. See text.

Fig. 2. See text.

This case had been that of a male negro, who died of pulmonary tuberculosis at the age of 47 years. The horseshoe kidney was not discovered during life. As the patient had given no history of symptoms referable to the abdomen or urinary tract, no roentgen examination had been made of this region. The significant anatomic findings were dense pleural adhesions and the usual disease condition seen in advanced pulmonary tuberculosis of both lungs.

On dissection, the parietal peritoneum was reflected from the lumbar and sacral regions. This revealed a large kidney mass consisting of two lateral lobes and an isthmus of apparently normal kidney tissue between the lower lobes. Each lateral lobe measured 13 cm. vertically, and the entire mass measured 17 cm. transversely. The isthmus lay over the bodies of the fourth and fifth lumbar vertebræ. Each lateral lobe possessed a hilum on its anterior surface from which the calices emerged to form the ureter. There were no distinct kidney pelves. The ureters passed downward over

[1] Visiting Professor of Anatomy, Division of Anatomy, College of Medicine, University of Tennessee, Summer, 1935.

the anterolateral surface of the lower poles, then across the terminal parts of the common iliac vessels, to enter the bladder in the usual manner (Fig. 1). Both kidneys were in symmetrical ptosis and in close proximity to the vertebral column.

The right and left renal arteries originated normally from the aorta and entered the upper part of their respective hila. Their accompanying renal veins entered the inferior vena cava. A branch of each common iliac artery entered the lower part of each hilum and the accompanying veins entered the common iliac veins. An anastomosing artery connected the hila. Another artery originated from the aorta just above its bifurcation and entered the left hilum and the isthmus of the kidney. The vein of this artery drained the isthmus and right hilum into the inferior vena cava.

Both suprarenal glands, which were quadrilateral in shape, were found in their normal upper abdominal positions, several inches above the kidneys.

In making the pyelo-ureterogram, the trunk was placed on the film in the proper position. Iodized oil (Iodochloral) was warmed and injected into the ureters through a small caliber needle passed obliquely through the ureteral wall. At their lower ends the ureters were ligated to prevent emptying of the oil into the bladder. After being completely filled, a distinct outline of the ureters and calices was obtained on the film (Fig. 2). The calices extended medially and laterally from their ureteral juncture, the majority being directed toward the mid-line. A portion of the isthmus below could be seen. One might receive the impression that more roentgenographic detail could be obtained in a specimen of this kind than in a living subject, but we did not find this true; a greater portion of the kidney tissue lay over the spine, and, the other viscera having been removed, there was a considerable variation in the density of the parts under study.

The findings typical of horseshoe kidney in this case, as revealed by the pyelo-ureterograms, were as follows:

(1) The vertical position of the two kidneys.
(2) The symmetrical ptosis.
(3) The close proximity of the kidneys to the vertebral column.
(4) The calices extending in two directions, the majority pointing toward the spine.
(5) The calices emptying into the pelves or ureters from the anterior aspect of the kidney tissue.
(6) The visibility of the isthmus.

The fact that anomalous kidneys are particularly susceptible to disease has been well established. It is worthy of note that this patient did not develop kidney disease even in the presence of advanced pulmonary tuberculosis.

We are indebted to Dr. Joseph L. Scianni, artist of the Pathologic Institute, University of Tennessee, for the illustrations in this paper.

A SUGGESTION FOR GALVANIC CURRENT APPARATUS

By ROBERT B. TAFT, M.D., B.S., M.A., F.A.C.R.
Charleston, South Carolina

The suggestion is made to those who use galvanic current in medical work, that many of the machines which employ rectified alternating current from the street mains are rather dangerous, as a breakdown in the apparatus can in certain instances throw an excessive amount of electricity into the patient. Recently a machine belonging to a colleague was tested because it had given a small burn on the arm of a patient, and was found to be delivering a surprising amount of alternating current even when the switch was in the "off" position.

The old type of radio "B" battery is an absolutely steady source of direct current which

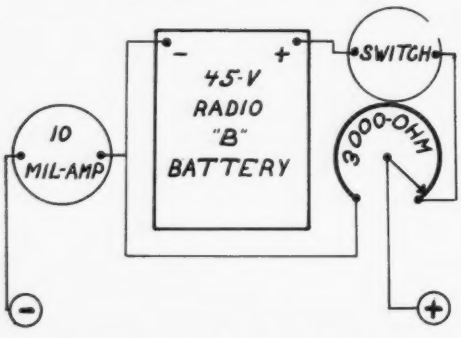


Fig. 1. Diagram of galvanic machine.

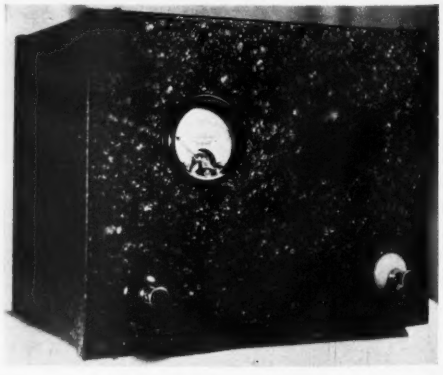


Fig. 2. Galvanic machine.

is quite adequate for most medical work, can be bought in any town, is inexpensive, and lasts from six months to one year with average use. The controller, milliameter, binding posts, and steel cabinet can be purchased from any large radio supply house.

In addition to being small, neat, and easily operated, it is absolutely safe under all conditions.

The diagram (Fig. 1) and photograph (Fig. 2) should need no explanation.

105 Rutledge Ave.

PRIMARY JEJUNAL ULCER

A CASE REPORT

By JOHN H. HARRIS, M.D., *Carlisle, Penna.*
Radiologist, Carlisle Hospital

In 1933, Eberling[1] reviewed the literature and reported a case of primary jejunal ulcer. He was able to find only 47 cases reported between the years 1827 and 1932. A case was recently examined in the Radiological Department of the Carlisle Hospital in which there were found two perforated primary jejunal ulcers.

H. S., male, aged 48 years, was first seen by his family physician in September, 1933, suffering with upper abdominal pain accompanied by vomiting of bile-stained material. There was some radiation of the pain toward the right lower quadrant suggesting an appendiceal attack. This attack soon subsided and he was again seen in December, 1933, with symptoms suggesting the presence of a gastric ulcer. These symptoms were controlled by ulcer régime. However, on Jan. 22, 1934, he developed another attack of acute abdominal pain, this time accompanied by hiccoughs. The examination of the abdomen was negative except for vague upper abdominal tenderness. White blood count was 15,000. After a week's stay in the hospital, the acute symptoms subsided and the patient was sent home without a diagnosis having been made.

Fig. 1.

Fig. 2.

In March he was admitted to the Carlisle Hospital for a gastro-intestinal x-ray study. The stomach was markedly cascade in type and contained a large amount of residue. There were numerous fluid levels in the large and small bowel. The large bowel was tremendously dilated by gas. At times during the fluoroscopic examination it seemed that an ulcer niche could be made out on the posterior wall of the stomach in the region just above the incisura angularis. However, the

[1] Eberling, Walter W.: Primary Jejunal Ulcer, Ann. Surg., June, 1933, **97**, 857.

Fig. 3. Gross specimen.

examination was extremely difficult, due to the distention of the large bowel, and it was impossible to be certain of the presence of an ulcer. The films revealed the presence of a fleck which led to the diagnosis of an ulcer on the posterior gastric wall (Fig. 1). The appearance of the distended colon with multiple fluid levels suggested lower bowel obstruction. For this reason a barium enema examination was done one week following the mouth meal. Again the fleck was seen in the same position as it was one week before when the stomach was being examined (Fig. 2). As no barium nor bismuth had been given the patient during the interval between examinations, it was concluded that a small gastro-colic fistula existed which permitted the ulcer niche to fill during the enema examination. Upon the basis of this diagnosis, an exploratory operation was performed on April 16, 1934, and no pathology was found by the surgeon. The appendix was removed and the patient made an uneventful recovery.

From this time the patient gained in weight and was able to resume his occupation as a railway station agent. He had little if any discomfort until Nov. 1, 1934, when there was a recurrence of the upper abdominal pain and vomiting. On Nov. 17, an attempt was made to make a fluoroscopic study of the stomach but the barium was vomited at once. For this reason and in view of the negative upper abdominal findings at operation six months previously, a barium enema was done. The colon was quite capacious, holding three and one-half quarts of solution. Nothing was found to account for the large bowel dilatation. Proctoscopic examination was negative. In spite of the negative findings, the markedly dilated colon with multiple fluid levels again suggested lower bowel obstruction and a second operation was planned. However, at 5 P.M. on the day preceding the one scheduled for operation, the patient went into shock and died within one hour.

At postmortem examination the abdomen was found to be filled with straw colored fluid in which floated intestinal content. The intestines were matted together by a plastic exudate. An abscess was found in the left upper abdomen in a curve of the distal transverse colon. This abscess developed from two perforated jejunal ulcers, which were opposite each other, one on the posterior and one on the anterior wall, and were located 4 inches from the duodenal-jejunal junction. There was a group of enlarged soft lymph nodes along the mesenteric attachment (Fig. 3). There was no evidence of mechanical obstruction of the bowel.

PATHOLOGICAL REPORT

Dr. Konzelmann, of Temple University, reported that sections from the margin of the ulcer and from the mesenteric lymph nodes showed no evidence of malignancy.

DISCUSSION

In retrospect, one may conclude that in September, 1933, the patient had his first perforation, and that his various acute attacks were due to slow leaks with the resulting peritonitis which in turn became walled off and permitted the acute symptoms to subside. The fleck, seen in the first fluoroscopic examination and thought to be on the posterior gastric wall, was barium in one of the jejunal ulcers, the shadow of which was superimposed upon the gastric shadow leading to the impression of a gastric ulcer. The finding of the fleck one week after the gastric examination was due to the retention of the barium in the deep ulcer crater.

The lesion was not found at the operation because sufficient exploration was not done. The presence of the markedly dilated colon which was found at each examination is difficult to explain. The ulcer and abscess were on the posterior peritoneum and could have caused the paralytic ileus by irritation of the retroperitoneal sympathetic plexuses.

It is quite probable that a correct diagnosis of this case could have been made had the small intestines been studied by the technic recommended by Dr. E. P. Pendergrass and his associates.

CONCLUSION

(1) A case of primary jejunal ulcer has been reported.

(2) Primary ulcers in this part of the bowel are quite rare, and more rarely still is the diagnosis made before operation.

EMPHYSEMA OF THE NECK FROM RUPTURE OF THE TRACHEA

REPORT OF A CASE

By ROBERT C. PENDERGRASS, M.D.,
Americus, Georgia

Subcutaneous emphysema from wounds penetrating the thoracic cavity is a common condition, but emphysema from wounds affecting the trachea or larynx alone is not so often noted. The following case is reported because of the unusual nature of the trauma, the rapid recovery under conservative treatment, and the graphic demonstration of the subcutaneous emphysema on roentgenologic examination.

Fig. 1. Anteroposterior view of neck immediately after injury.

Fig. 2. Anteroposterior view of neck eight days after injury.

Fig. 3. Lateral view of neck immediately after injury.

Fig. 4. Lateral view of neck eight days after injury.

On April 8, 1935, a negro boy, aged seven years, fell across the arm of a rocking chair with his neck extended. Immediately afterward he complained of pain, shortness of breath, and a choking feeling. The mother noted marked swelling of the neck. He was brought to the office within ten minutes after the injury, at which time there was definite swelling of the soft tissues of the neck from the clavicles to the mandibles and extending back to the lateral mid-line. There was definite crepitation on palpation. No break could be found in the skin, but a small bruise was noted below the level of the larynx. A diagnosis of rupture of either the trachea or the larynx was made from the clinical findings.

Radiographs showed an extensive subcutaneous emphysema of the anterior half of the neck, but it was impossible, because of the confusing shadows of the air-inflated soft parts, to determine the exact site of the break in the trachea.

Dr. S. A. Scruggs was called in consultation. The patient was placed in the hospital, and an ice collar kept constantly to the neck to reduce edema. Morphine was given in sufficient doses to prevent restlessness, minimize coughing, and keep the respiratory rate normal. In one week the emphysema had completely subsided. Observation at two months and again at nine months after the accident showed no residual effects.

CONGENITAL DEFECT OF THE LEFT HALF OF THE DIAPHRAGM

REPORT OF EXAMINATION OF A FOUR-DAY-OLD INFANT

By W. O. WEISKOTTEN, M.D., *San Diego, California*

Congenital defects of the diaphragm have been recognized and described by numerous observers, but the following case was interesting because of the age of the child at the time of examination.

Fig. 1. Four-day-old infant at the time of first examination.

A four-day-old Portuguese infant was referred for roentgen examination for a suspected enlarged thymus. The parental history was unimportant and the delivery had been normal. Shortly after birth, the infant presented signs of difficult breathing, especially while nursing, and cyanosis, with extremely rapid respiration and pulse. This difficulty was more pronounced when the infant was prone, being somewhat relieved when the baby was held in an upright position. The attending physician suspected an enlarged thymus and requested an examination to determine if such a condition existed.

The usual films for thymus examination were made with the baby held in the upright position and with the postero-anterior projection (2). There was no evidence of an enlarged thymus, but the outlines of the gas-distended colon, proximal to the splenic flexure, were demonstrated within the chest cavity. A barium enema was immediately given under fluoroscopic control, followed by the making of films of the injected bowel (3).

This examination gave the following information. There were no typical gas shadows in the abdomen. The pelvic colon was negative, and the descending colon extended in a straight diagonal line to the splenic flexure. The colon, proximal to the splenic flexure, was entirely within the chest cavity, and the transverse colon was in close relation to the left lateral chest wall. The hepatic flexure extended to the extreme upper limit of the chest cavity, and the proximal colon, which was moderately dilated, looped back behind the transverse portion of the bowel. The heart was displaced to the right and was in contact with the right lateral chest wall. It was assumed we were dealing with a deficiency of the left half of the dia-

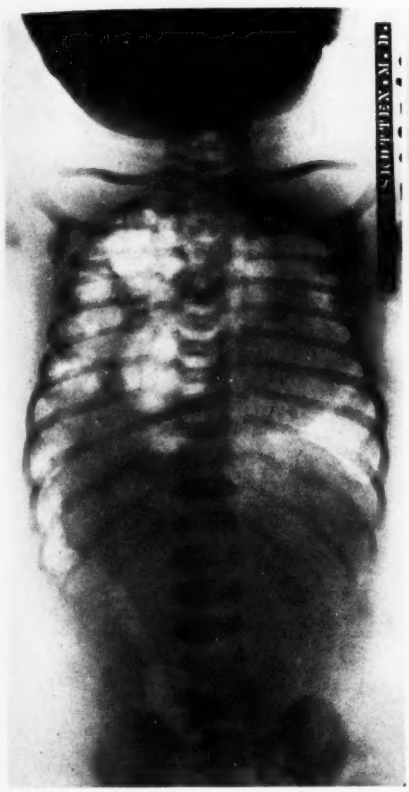


Fig. 2. Film without contrast injection.

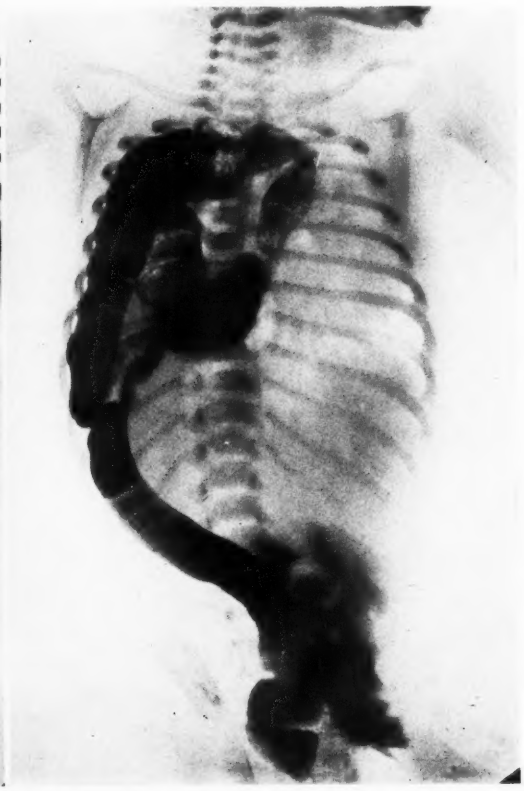


Fig. 3. Barium enema. (The shadow without the colon is spilled barium mixture.)

phragm, with displacement of the abdominal contents into the chest cavity.

Two days later, the infant was returned for further observation. With fluoroscopic control, a barium-milk mixture was injected through a small catheter, into the stomach. The examination demonstrated the stomach and small intestines to be entirely within the chest cavity, to the left of the median line and with the heart displaced to the right (Figs. 4 and 5). The infant continued to have more difficulty in breathing and taking food, and died on the seventh day after birth.

The autopsy report by Dr. C. J. Osborne was as follows: Examination of a well-nourished female infant, born on July 7, 1935, died on July 14, 1935. The external appearance is that of an apparently normal, well-formed infant. The thorax and abdomen were opened with the usual incisions. The sternum and costal cartilages were turned back to allow inspection of the chest cavity.

There is an hiatus in the rudimentary left diaphragm, 4.5 cm. in diameter, which will admit three fingers. This new opening is surrounded by a rather dense circular fibrous ring which rolls under the fingers. This opening corresponds to the mid to lateral portion of the diaphragm and is not an enlargement of a normal hiatus. There are a few thin muscle fibers in the left diaphragm. The right diaphragm is well developed and normal; the left diaphragm is more like a thin membrane.

The esophagus is displaced to the right. The stomach, small intestines and the colon, proximal to the splenic flexure, are entirely within the chest cavity, occupying the left and part of the central portion of the thorax. The heart is normal as to size, displaced to the right chest wall, and with the apex in the right mammary line. The left lung is collapsed and compressed to the size of approximately 2×3 centimeters. The right lung is enlarged and, on section, shows the usual postmortem appearance. The spleen is entirely within the left chest cavity and is held by adhesions to the rudimentary left diaphragm. The thymus is normal in size. Many adhesions fix the stomach and small and large intestines to the posterior chest wall and mediastinum.

Fig. 4. Barium-injected stomach and small intestines in the chest cavity.

Fig. 5. Lateral view of barium-injected stomach.

The liver is greatly enlarged, and the right kidney is about twice normal size. The left kidney is very small, about the size of a hickory nut. The gall bladder is the size of a small bean. The descending colon extends in a straight line from the pelvic colon to the opening in the diaphragm. An attempt was made to replace the abdominal contents through the circular fibrous ring in the left diaphragm. This was almost impossible on account of the many firm adhesions which held the displaced viscera high in the chest cavity.

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EDITORIAL

LEON J. MENVILLE, M.D., *Editor* HOWARD P. DOUB, M.D., *Associate Editor*

IS IRRADIATION A CURE FOR CANCER?[1]

This title might be classified as Foolish Question Number 1, since it can only be answered both *yes* and *no*. However, it is not my intention to be facetious, but rather to discuss the results that may reasonably be expected from this mode of treatment of cancer.

The practice of "trying x-ray treatment to see what will happen" may occasionally be justifiable, but to do this habitually implies the neglect of a correct appraisal of each case which is absolutely essential to correct treatment.

Experience in the treatment of this disease must convince anyone that if the first treatment carried out in any case is ineffectual, the chances of ultimate cure are greatly reduced because of such treatment.

For this reason one should attempt to decide before applying irradiation in a given case whether the effect will be only palliation, whether there is a reasonable chance of cure, or whether some other mode of treatment offers better chances of success. Naturally, experience is an enormous asset in making such a decision, but an equally valuable aid is consultation with the surgeon, pathologist, and other specialists as may be indicated. I cannot speak too enthusiastically of the advantages of a well-organized tumor clinic in deciding the method of attack in a case of cancer.

Having arrived at a point where irradiation has been decided upon, let us return to our original query, "Is irradiation a cure for cancer?" The first and most obvious answer is that it depends upon who applies the radiation.

It is not irradiation which cures cancer, but the physician giving the treatment. I suppose no one would contradict this statement, yet the fact is ignored so frequently that it deserves discussion.

The tools of the radiologist (x-ray machines and radium) are unique both in their costliness and their comparative rarity, and undoubtedly these facts have tended to emphasize the importance of the tools over that of the user of them. If a hospital spends many thousand dollars for radiation equipment and employs a radiologist for a few thousand a year, the business management can hardly be blamed for placing the greater emphasis on what costs the most. Consequently, hospitals are apt to stress expensive equipment rather than skillful radiologists. Medical ethics prevent the radiologist from combating this type of propaganda if he could.

The fact that x-ray apparatus is still in a state of development and that most of the changes brought out are improvements and not just something new, might also lead one to believe that the institution with the newest apparatus must necessarily produce the best results.

Naturally, equipment must be adequate, but it is just as ridiculous to select a place for x-ray treatment by the size of the equipment as it would be to select a surgeon by the number of instruments he owns. The radiologists themselves are not altogether blameless in this matter since they have made little effort to stress the necessity for special training in order to practise radiotherapy, and even less effort to provide suitable and adequate facilities for teaching this highly technical specialty. Too often the purchase of the necessary x-ray apparatus or radium has been considered sufficient preparation, and since the laws of most States allow a physician to practise any medical specialty he chooses, without proving his competence, one can hardly be surprised if the importance of special training has been disregarded.

As long as the laws of this country ignore medical specialism, the only factor which will control abuses is public opinion. The establishment of voluntary National Boards in various specialties has done a great deal to counteract the deficiency in our laws, and I am happy to say that the National Board of Radiology is performing a definite service to radiology and the profession in general in certifying to the competence of applicants in roentgen diagnosis and in roentgen or radium therapy.

[1] Read before the Pittsburgh Academy of Medicine.

I have digressed somewhat from the statement that the results from irradiation depend more upon the manner in which it is applied than upon the powerfulness of the apparatus used, provided always, of course, that the equipment is adequate for the purpose at hand. To substantiate this statement I will cite two specific instances with which I think all radiologists will agree.

The first refers to the treatment of superficial malignancy, the ordinary epithelioma of the face or lip, for example. There is general agreement, I believe, that the best way to treat this lesion is by a massive dose of unfiltered radiation applied in a short period of time so as to produce a single overwhelming effect (I refer here to uncomplicated cases). As a result of such treatment more than 95 per cent of cures may be expected.

Yet with the use of the same x-ray apparatus, operated at the same voltage, with the same x-ray tube and all other factors being the same, one may treat such a lesion every two or three weeks for a year and a half without any appreciable effect. I have seen dozens of cases which have been treated like this and which were promptly cured *when treated in the proper manner.*

The second instance I will cite as evidence that the manner of application is responsible for the effect is the "Coutard method." Professor Coutard has developed a technic for the treatment of carcinoma in the pharynx and larynx which is so superior to any other that it might almost be termed miraculous. In this method the various factors involved such as voltage, size of dose, interval between treatments have been established to such a critical point that the slightest variations nullify the result. This method of treatment is a perfect example of the vital necessity of "knowing how."

Incidentally, I might mention that Coutard treatment always produces what is commonly called an x-ray burn, with blistering and ulceration of the skin. This is a necessary part of the treatment and results cannot be obtained without it. Yet in some of our States the courts still hold that the presence of an "x-ray burn" is *prima facie* evidence of neglect.

The poor victim of cancer of the pharynx or larynx may either die without an effort being made to save him, or the radiologist may lay himself open to prosecution for malpractice if he treats him properly. This is a situation in which the support of the entire medical profession is necessary, and the truth about "x-ray burns" in this method of treatment should be disseminated as quickly as possible.

I have mentioned only two instances in which definite method of application produces specific results. There are many others applicable to various diseases or situations and probably many not yet developed. The point I have tried to make is that irradiation is a tool in the hands of the radiologist with which he produces results depending entirely upon his skill and experience.

The second factor to be considered is the question of cure. I may say at once that I doubt if anyone can ever say for certain when a cancer is cured.

I have seen a patient who has been operated upon for cancer of the breast remain well for eighteen years and then develop a recurrence from which she died. While this is the longest period I have definitely known cancer to lie dormant, I have seen scores of cases remain well for the five-year period often arbitrarily chosen as indicating a cure, only to succumb later to the disease.

Many pathologists have had the experience of examining tissue removed after extensive radiation, and in the midst of dense areas of fibrosis produced by the treatment have found viable cancer cells which conceivably might reproduce the lesion.

In the face of these facts, when may we say that a cancer is cured? However, without being too literal let us discuss the possibilities of cure as ordinarily accepted.

We find cancer of the skin in a class by itself in that a very high percentage of cases are permanently cured. There are two reasons for this: (1) these lesions seldom metastasize; (2) a dose of radiation may be used which is absolutely destructive to the lesion without serious complications arising in contiguous normal structures.

It is true that a certain amount of normal tissue near the lesion may also be destroyed, but this is not a vital matter since the destroyed area almost always heals in by granulation, and if by any chance it should not, resort may be had to skin grafting or a plastic operation.

However, when epithelioma occurs in other locations such as the mouth, pharynx, larynx, or cervix of the uterus, the problem becomes at once more complicated.

In the first place, these lesions metastasize and after this has taken place, one must treat not only the primary lesion but also an un-

known number of secondary lesions in locations at which one can only guess. In addition, these secondary lesions are always more virulent and radioresistant than the primary one.

In carcinoma of the mouth, radium has revolutionized treatment to the extent that the primary lesion is controlled in a high percentage of cases—probably more than 50 per cent of all cases. The Coutard method of treatment promises to yield equally good results in carcinoma of the pharynx and larynx.

However, the cervical metastases which occur in all these lesions present a still unsolved problem. Block dissection has been disappointing. There does not seem to be any theoretical reason why Coutard treatment may not be the answer to this problem. The superficial location of the glands makes it easy to apply large dosages, which, as a matter of fact, set up violent inflammation in the pharynx and larynx. The effect of these large doses of radiation on normal tissues near the glands, while undoubtedly producing permanent changes, would not conceivably threaten life. As a matter of fact, the results so far obtained are very promising, although complicated by an extensive induration of tissues of the neck.

However, it seems possible that early cases of cancer of the mouth and throat with metastases limited to the cervical region may yield a gratifying percentage of cures. Metastases to the mediastinum and lungs make such cases incurable in the light of all our present knowledge.

When we come to consider carcinoma of the uterus, bladder, rectum, or elsewhere in the abdomen, the problem becomes an entirely different one. Here we cannot apply the destructive doses that we use on the skin, or even the Coutard treatment that we use in the mouth and throat. The application of such doses to normal abdominal structures, such as bowel, for instance, would be disastrous, to say nothing of the bladder itself.

In treating cancer in this region we can only apply a dose to the diseased area which will be tolerated by surrounding normal structures without disastrous results. The epithelitis which we produce in the throat is painful but not fatal, and if worst comes to worst, a tracheotomy and artificial feeding are our most serious complications. However, such a lesion produced in the bowel would be fatal.

It does not seem possible, therefore, that we can ever apply sufficient radiation to destroy metastases in the abdomen, pelvis, or chest without producing disastrous effects on normal tissues, since the toleration dose to cancer and normal cells is about the same. It is, of course, possible that some method of applying irradiation may be discovered which will cause involution of cancer cells without destruction of normal tissues, but at the present time no such method is known.

It was thought for a time that x-rays produced at very high voltages might have a selective action against cancer cells, but experience with this apparatus indicates that this is not the case. The advantage of higher voltages seems to rest entirely in the ability to apply larger doses deep down inside the body, but one is still limited by the amount of radiation the exposed normal tissue will tolerate.

The second factor which makes the treatment of cancer difficult is the tendency to distant metastases, such as commonly occur in lymphatic glands, bones, liver, lungs, and brain. Not only are they very difficult to control when recognized, but they are apt to develop to an advanced stage before they are even suspected. Until some method is discovered whereby the presence and extent of metastases may be determined, the results in the treatment of deep-seated malignancy by irradiation are likely to remain uncertain. As long as the disease remains localized there is always the possibility of cure; if distant metastases have occurred, cure is highly improbable.

The remaining factor which influences results is the type of cancer present. While much work has been done in an effort to classify the grade of radiosensitivity according to histologic structure, there is no general agreement on this point. Some authors feel that they can predict the reaction of the tumor to irradiation by a study of its microscopic structure, while others are very undecided on this point. In a general way it is recognized that the highly cellular type is apt to be radiosensitive, but there are undoubtedly exceptions to this rule.

In my own practice I have not been able to derive much practical benefit from a knowledge of the cellular structure of the tumor. It is certainly not safe to apply smaller doses than usual to cases which microscopically would seem to be radiosensitive.

In conclusion, the answer to the query "Is irradiation a cure for cancer?" might be stated as follows: It depends upon the type, extent,

and location of the lesion, the general condition of the patient, the presence of metastases, and upon the skill and experience of the individual applying the treatment.

G. W. GRIER, M.D.
Jenkins Arcade Building
Pittsburgh, Pa.

COMMUNICATION

PEPTIC ULCER X-RAY A-B-C'S[1]

Aims of the routine examination for peptic ulcer are:
(1) Demonstration and location of the lesion,
(2) Character and size of the lesion,
(3) Progress or healing of an established lesion.

Both radiography and fluoroscopy must be used to accomplish these aims: radiography for study of details and purposes of record and comparison; fluoroscopy for observation of peristalsis and motor phenomena.

Classification of ulcers roentgenologically is usually a fusion process: from the pathologist we borrow terms like "shallow" or "mucosal," "penetrating" and "perforating"; for the clinician's benefit our reports mention obstruction and other clinical features.

Direct and indirect signs for the basis of our diagnosis; direct—ulcer niche (crater), accessory pocket, organic hour-glass, cicatricial deformities; indirect—incisuræ, spasms (cardio-, gastro-, pyloro-), changes in peristalsis and motility, barium retention, tenderness, etc.

Etiology lies outside the scope of roentgenologic examination.

Frequency figures are interesting. The ratio of esophageal, gastric, and duodenal ulcers is about 1:30:-180.

Generally, esophageal ulcers are shallow and cannot be visualized directly. Gastric and jejunal ulcers usually exhibit more direct signs. All pathologic and roentgenologic varieties are seen in the duodenum where 95 per cent of all ulcers occur in the bulb.

Historically, the highlights in the evolution of ulcer diagnosis are:
(1) Introduction of the barium meal (1904),
(2) Discovery of the gastric niche (1910),
(3) Visualization of duodenal ulceration (1910),
(4) Outlining of mucosal relief (1925).

In accuracy, x-ray diagnosis has reached a stage where a peptic ulcer can be definitely determined and localized in from 90 to 99 per cent of all cases.

Jejunal ulcers show—beside evidence of surgical intervention and high percentage of niches—"puckering" of gastric stoma, frequent stenosis, localized tenderness and, in about 11 per cent, gastro-jejunocolic fistula.

Know your antispasmodics (atropin, etc.) for the checking of spasm. Use them effectively; time them correctly; avoid incompatibilities.

Location of the ulcer is very important not only for the surgeon but also for the diagnosis of malignancy.

Malignancy is described as a sequela of gastric ulcer, especially of those outside the midsection of the smaller curvature and of craters with over 2 cm. diameter. Roentgenologically, Carman's "meniscus sign" is considered pathognomonic.

Niches can be demonstrated in about 50 per cent of gastric ulcers, in about 75 per cent of jejunal ulcers and, by relief-compression technic, in about 55 per cent of duodenal ulcers.

Occasionally, x-ray findings are at variance with operative or autopsy findings. One reason: barium cannot outline the soft tissue involvement. Another reason: anesthesia and death eliminate all spastic disturbances with which the roentgenologist must cope.

"Pine-trees" and "shamrocks" may conjure romantic memories in the reader's mind. To the x-ray man they mean—like "Cole's defect" and "Akerlund's deformity"—just typical duodenal ulcer deformities.

Quiescence of symptoms is often entirely disproved as a sign of cure by roentgenology.

Relief outlining of the mucosal rugæ has markedly improved results but requires much patience and even more experience.

"Skipping" of peristalsis is a very valuable sign in ulcer diagnosis.

Time, age, and response to treatment are important factors for the differentiation of ulcer and cancer.

Unfortunately, the determination of ulcer cure is very difficult.

Visualization of healing depends on many vaguely defined changes. The indirect (spastic, etc.) signs should disappear; the direct signs (niche, etc.) may disappear or persist due to fibrosis and scar formation.

When all is said, and no matter how skeptical you may be about things printed in medical magazines,

X-rays are indispensable for present-day medicine and surgery, and

You will admit that no examination for peptic ulcer can be considered final without the use of x-ray, and that it is

Zimply impossible to cover this subject intelligently in two columns of "Colorado Medicine."

—E. A. S.

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ANNOUNCEMENT

MEDICAL SOCIETY OF THE STATE OF NEW YORK

PROGRAM OF SECTION ON RADIOLOGY

The Waldorf-Astoria, Carpenter Salon

Tuesday, April 28, 10:00 A.M.

1. "Cancer of the Esophagus." WILLIAM L. WATSON, M.D., New York City. Discus-

cussion opened by JAMES EWING, M.D., New York City, and D. E. EHRLICH, M.D., New York City

2. "Roentgenological Consideration of Dysphagia of Esophageal Origin." JOHN M. BARNES, M.D., Buffalo. Discussion opened by BARNEY B. SMITH, M.D., Buffalo

3. "Roentgen Diagnosis of Malignant Tumors of the Stomach." GEORGE T. PACK, M.D., New York City, and HARRY HAUSER, M.D., Cleveland, Ohio (*invited guest*). Discussion opened by JAMES M. FLYNN, M.D., Rochester

4. "Presentation of Automatic Electric Serialograph with Cassette Holder." MOSES EINHORN, M.D., New York City

Wednesday, April 29, 10:00 A.M.

1. "Irradiation in Thyrotoxicosis." J. THOMPSON STEVENS, M.D., New York City. Discussion opened by LUCAS S. HENRY, M.D., Syracuse

2. "Hodgkin's Disease with Bone Manifestations." SAMUEL GEORGE SCHENCK, M.D., Brooklyn. Discussion opened by LLOYD F. CRAVER, M.D., New York City

3. "Suppuration in the Pneumatic Petrous Apex." HENRY K. TAYLOR, M.D., New York City. Discussion opened by FREDERICK M. LAW, M.D., New York City

4. "A Review of the Bony Changes in Cases of Arthritis Treated by Fever Therapy." S. C. DAVIDSON, M.D., and STAFFORD L. WARREN, M.D., Rochester

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IN MEMORIAM

W. G. BAIN, M.D.

The Radiological Society of North America has lost in Dr. Bain one of its oldest members and one whose loss is very deeply felt by his many friends. Dr. W. G. Bain died in Springfield, Illinois, on Dec. 25, 1935, following a surgical procedure.

He had received his A.B. degree from the University of Michigan in 1903 and his M.D. from Northwestern University Medical School in 1905. Since 1910 he had been associated with St. John's Hospital in Springfield, and at the time of his death he was Chief Roentgenologist and Medical Director of the organization. During his long association with St. John's Hospital, Dr. Bain had succeeded in developing a most complete and efficient roentgen-ray department. In 1925 he was elected President of the Illinois Academy of Medicine and of the Sangamon County Medical Society. He was one of the charter members of the Illinois Radiological Society.

Dr. Bain's death deprives many organizations of one of their oldest and most active members. His personal kindness and his constructive spirit will not be forgotten by those who had the good fortune to be associated with him.

Portrait loaned by the Sangamon County Medical Society

The late W. G. Bain, M.D.

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S. M. Atkins, M.D., of Waterbury, Conn.
George E. Burch, Jr., M.D., of New Orleans
William H. Gillentine, M.D., of New Orleans
E. A. Pohle, M.D., Ph.D., of Madison, Wis.
E. M. Shebesta, M.D., of Detroit, Mich.
William A. Sodeman, M.D., of New Orleans
Charles G. Sutherland, M.B. (Tor.), of Rochester, Minn.

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ANEMIA, PERNICIOUS

Variations in the Gastric Mucosa in Pernicious Anemia: Gastroscopic, Surgical, and Roentgenologic Observations. Chester M. Jones, E. B. Benedict, and A. O. Hampton. Am. Jour. Med. Sci., November, 1935, **190,** 596–610.

Jones, Benedict, and Hampton have observed changes in the gastric mucosa in pernicious anemia by a combination of three methods: gastroscopic, roentgenologic, and direct surgical inspection. Roentgenologic observations were made by the compression technic for the demonstration of the mucosal markings of the stomach.

Five cases, observed before and after successful treatment, indicated that, contrary to most observers, atrophy of the stomach occurred particularly during a relapse, and not as an invariable accompaniment of the disease. Following specific therapy, evidences of atrophy and hypertrophy of the stomach both tended to disappear. Roentgen-ray examinations constituted an interesting check on the other observations but gave much less accurate information than that obtained either by gastroscopy or by direct examination at operation. The chief value derived from the roentgen ray was that of noting progress in a given case.

WILLIAM A. SODEMAN, M.D.

ANIMAL EXPERIMENTATION

The Effect of Single Doses of Roentgen Rays on the Rhythm of the Spermatogenesis in the Testicle of the Mouse. H. Langendorff. Strahlentherapie, 1936, **55,** 58.

The author chose the testicle as the object for his studies because this tissue is highly radiosensitive and also because it permits the use of a large number of cells, thus lending itself to statistical evaluation. He examined 1,000 testicles and counted between 1,500,000 and 2,000,000 cells. The results agreed in general with those reported by other investigators who worked on the cornea of a salamander larva, the roots of beans, and tissue cultures. The periodical change in the reaction of a tissue must be regarded as a characteristic property belonging to all irradiated tissues in the same manner.

This should induce us to study further the rhythm of irradiation so that it may be possible to expose a tissue at the height of its susceptibility. In the author's opinion such investigations would undoubtedly lead to an increase in the efficacy of radiation therapy in malignant disease.

ERNST A. POHLE, M.D., Ph.D.

Production of Nephritis in Dogs by Roentgen Rays. Irvine H. Page. Am. Jour. Med. Sci., February, 1936, **191,** 251–256.

Page has produced experimental nephritis in dogs by irradiation of the kidneys after transplantation to a position directly beneath the skin of the loin. This method has the advantage of precise regulation of the irradiation, which is limited to the kidneys only and may be given in repeated doses. Urinary findings of nephritis developed—casts, albumin, and occasionally red blood cells. The irradiated kidneys became smaller. The nephritis, however, differed in its manifestations from that observed in humans in the development of hemoconcentration with increased hemoglobin rather than anemia. The urea nitrogen became elevated and the plasma lipid changes were similar to those observed in patients in terminal chronic hemorrhagic nephritis.

Nephritis produced in this manner leads to death in the course of a few months, with symptoms typical of renal failure.

WILLIAM A. SODEMAN, M.D.

APPARATUS

Sources of Error in Temperature Measurements in the Short Wave Condenser Field during the Treatment. J. Patzold. Strahlentherapie, 1935, **54,** 362.

The author has constructed a special quartz benzol thermometer which can be used for temperature measurements during treatments given with the ultra-short electric wave apparatus. Detailed instructions are outlined so as to avoid errors in the determinations.

ERNST A. POHLE, M.D., Ph.D.

ARTHRITIS

Gold Therapy in Arthritis. Editorial. Jour. Am. Med. Assn., Dec. 28, 1935, **105,** 2163, 2164.

In a general discussion of the use of gold as a remedy, aurotherapy is given no great value in acute and subacute rheumatism in children and it is contra-indicated when severe carditis is present.

In rheumatoid arthritis and early ankylosing spondylitis, 70 to 80 per cent of 500 patients in Forestier's series have responded well. Of these, 50 per cent in recent cases and from 20 to 30 per cent of cases of more than two years' duration are reported to have been permanently cured by from two to five series of treatments and have remained cured without further treatment for from two to three years.

Results in smaller series were encouraging. All reports are in agreement as to the toxicity of gold compounds. The only efficient safeguard is systematic platelet counts. At the present time no one who is not thoroughly familiar with the indications and dangers should attempt its use.

CHARLES G. SUTHERLAND, M.B. (Tor.)

Atrophic and Hypertrophic Arthritis: Roentgen Diagnosis. Kenneth D. A. Allen. Colorado Med., February, 1936, **33,** 91–95.

The author lists and discusses the roentgen signs of atrophic and hypertrophic arthritis and describes the pathologic cause of the x-ray appearance. He considers that haziness of the joint area, symmetrical joint space

narrowing, bone atrophy, bone destruction, periarticular loss of soft tissues, and ankylosis are characteristic of atrophic arthritis; and that marginal bone lipping, asymmetrical joint space narrowing, spotty atrophy, eburnation, irregular joint margination, and joint mice are characteristic of hypertrophic arthritis. Apparently it is unusual for any one case to present all of the characteristic findings.

WILLIAM H. GILLENTINE, M.D.

ASTHMA

Wheat Hairs and Dust as a Common Cause of Asthma among Workers in Wheat Flour Mills. W. W. Duke. Jour. Am. Med. Assn., Sept. 21, 1935, **105,** 957, 958.

The author reports four patients all of whom gave a like history of finding that they were subject to asthma while working in wheat mills, especially on windy days and when they worked in certain rooms in which they were exposed to the dust that came from the first cleaning of the wheat grain. The most severe attacks followed mishaps in the machinery of the mill or the cleaning of apparatus or rooms that exposed the workers to unusually large amounts of this dust.

Apparently sensitization came on after several years' work in a mill and gradually increased in severity until it resulted, in two cases, in an illness that caused the patients to quit milling in spite of treatment with extract from wheat hairs and dust, which reduced the frequency and severity of their attacks.

CHARLES G. SUTHERLAND, M.B. (Tor.)

BIOLOGIC EFFECTS OF RADIATION

The Influence of Roentgen Rays on Vitality, Development, and Sex. E. Knapp and H. Schreiber. Strahlentherapie, 1936, **55,** 32.

The author studied the effect of roentgen rays on a moss (*Lebermoos sphærocarpus donnellii*) by exposing it at various stages of the developmental cycle to doses of from 2,000 to 5,000 r. The experimental method and results are described in detail. Of general interest is the observation that the normal ratio of sexes changed following irradiation in favor of the males. The authors explain this by a decrease of the vitality of the females and also by transformation of females into males (mutation of chromosomes).

ERNST A. POHLE, M.D., Ph.D.

Comparative Study of the Effect of Roentgen and Gamma Rays on the Living Cell. L. Mallet. Strahlentherapie, 1936, **55,** 48.

Eggs of *Lucilia sericata* were exposed to roentgen rays (100 kv., 5 mm. Al; 200 kv., 1.5 mm. Cu + 3 mm. Al) and gamma rays of radium (filter: 2.0 mm. Pt). The percentage of injury was independent from the wave length; no proportionality existed between dose and effect. Comparing the effect of roentgen rays and gamma rays it appeared that 25 per cent mortality required 100 r of gamma rays but 150 r of x-rays. The possible explanation for this observation is briefly discussed. The temperature affects the resistance of the eggs; it increases with decreasing temperature. Epilation in man occurred following 350 r, regardless of the quality of radiation, when comparing 200 kv. filtered through 1.0 mm. Al or through 0.5 mm. Cu + 2 mm. Al.

ERNST A. POHLE, M.D., Ph.D.

Quantitative Interpretation of Biological X-ray Effects. Fred M. Uber. Proc. Soc. Exp. Biol. and Med., January, 1936, **33,** 508, 509.

Uber concluded that the marked concentration in the chromosomes of elements of comparatively high atomic weight, as potassium, calcium, phosphorus and probably iron, may be related quantitatively to x-ray phenomena in at least the three following ways:

"First, rough calculations based on microincineration evidence and on the composition of nucleic acid indicate that the mass absorption coefficient of chromatin is more than double that of air and, hence, that of nucleoplasm. This relatively greater absorption of radiant energy by the chromosomes may account in large measure for the greater sensitivity of the nucleus compared to the cytoplasm, an experimental fact confirmed by a number of investigators.

"Second, the amount of chromatin in a 'sensitive volume,' a concept associated with the quantum hit theory of radiation injury, would be but a fraction of that computed for it on the ordinary assumptions, *i.e.*, those which underlie the definition of the roentgen as a dosage unit. Were the validity of the theory established and relevant measurements precise enough, this size factor might prove important in assigning the 'sensitive volume' to a definite cytological entity.

"Third, the localization of nuclear ash in the chromosomes should manifest itself in a biologically detectable wave length effect at the absorption discontinuity of any comparatively heavy element present in relative abundance. The fact that the wave lengths for the elements concerned lie in the range, 3–6 Ångström units, probably explains why no such effect has been discovered to date. Conversely, if a sufficiently sensitive criterion of biological effect could be found, perhaps some genetic change, it would serve as a test for the presence of specific heavy elements in the hereditary material."

GEORGE E. BURCH, JR., M.D.

BONE DISEASES (DIAGNOSIS)

Roentgenologic Bone Changes in Sickle-cell and Erythroblastic Anemia: Report of Nine Cases. Andrew G. Grinnan. Am. Jour. Roentgenol. and Rad. Ther., September, 1935, **34,** 297–309.

A description of both the roentgenologic and clinical findings of nine cases is presented. The bone changes in both are so similar that they cannot be differentiated.

The skull shows thickening of the frontal, parietal, occipital, and temporal bones, with thinning of the inner tables and very thin or absent outer tables. The long bone changes consist of cortical thinning, expansion of the shafts and medullary trabeculations, and in the pelvis and scapula, striations. These changes may be present in varying degrees or may even be absent.

Although sickle-cell anemia usually occurs in the negro and erythroblastic anemia in the Mediterranean races, they may occur in other races.

S. M. Atkins, M.D.

BONE DISEASES (THERAPY)

The Relief of Pain by Roentgen Irradiation in Paget's Disease of Bone. Cassie B. Rose. Am. Jour. Roentgenol. and Rad. Ther., September, 1935, **34,** 374–377.

Four cases of Paget's disease, two of which were limited to single bones, were treated for the pain, and beneficial results are reported. Calcium lactate and glucose were given in conjunction with this treatment. A tension of 140 kv. was used and 350 r per treatment. The number of treatments varied from one per area to many over an extended time.

S. M. Atkins, M.D.

BONE GROWTH

Growth Arrest in Long Bones as Result of Fractures that Include the Epiphysis. Edward L. Compere. Jour. Am. Med. Assn., Dec. 28, 1935, **105,** 2140–2146.

Haas has stated that trauma is the most frequent cause of disturbances of growth in bones. The greatest growth activity is localized in the cartilage columns on the metaphyseal side of the epiphyseal cartilage plate. After the destruction of this portion of the growth cartilage, length growth practically terminates. Experimental investigation demonstrated that injury of the epiphysis alone or to the metaphysis alone caused very little change in the rate or extent of growth of the extremity. Injuries to the shaft of the bone that extended to and across the epiphyseal line, injuries to the epiphysis that included in the applied trauma a portion of the cartilage plate, or direct insult to the growth cartilage alone, did cause an early closure or a complete arrest of growth from the traumatized end of the bone. The stripping of soft parts from the edges of the epiphyseal cartilage plate or the mere passage of sutures through the actively growing columns of cartilage cells of the cartilage plate resulted in the arrest of growth.

The author reviewed the fractures of the long bones treated in the University of Chicago clinics over a given period. 34 per cent (211) of the total number were in children 14 years of age or younger at the time the fracture occurred. In 37 of the 211 cases the fracture involved the growth cartilage. In 19 cases which had adequate roentgen follow-up examination, 18 showed definite growth arrest.

The clinician should be reserved in the prognosis in the cases of such fractures and should follow these patients with periodic roentgen examinations for from one to two years after union of the fracture has taken place.

Charles G. Sutherland, M.B. (Tor.)

Growth of Long Bones. Editorial. Jour. Am. Med. Assn., Dec. 7, 1935, **105,** 1917.

The recent detailed study by the Bisgards (Arch. Surg., 1935, **31,** 568) leaves little to be desired in detail and accuracy of direct measurements of the longitudinal growth of long bones. The study covered prenatal and postnatal growth. In the postnatal study, when the animals (new-born goats) were from two to five days old, the bones were marked with steel shots placed in drill holes in the shafts. Roentgenograms were taken of the bones at the beginning and the end of the experiments and at intervals during the course of investigations extending over a 12 to 18 months' period, the span of the major growth. Final measurements from which growth calculations were made were obtained by actual measurement of postmortem examinations.

It was observed that the lengthening of long bones, which occurs at the ends, takes place by the deposition of layers of new bone between the end of the diaphysis and the epiphyseal cartilage and between the articular cartilage and the epiphysis. The proportion of longitudinal growth from the two ends of a long bone was found to be unequal. The rate of growth remains constant during the first two months and then progresses at half its former rate. The epiphyseal cartilage, giving the lesser increment of growth, is the first to ossify and close.

In the prenatal growth study phosphorus fed to the mothers produced arrest lines in the bones of the fetus. This study demonstrated that prenatal as well as postnatal longitudinal growth of the long bones takes place at the ends, but that the growth from the two ends is proportionately more nearly equal before than after birth, particularly during the first portion of prenatal life.

Charles G. Sutherland, M.B. (Tor.)

THE BRAIN

Roentgen Therapy of Brain Tumors. E. Bandhauer Strahlentherapie, 1936, **55,** 133.

The author has given higher doses than recommended in the literature in the treatment of brain tumors. He aims to administer 250 per cent H.E.D. within the tumor and uses five fields. Each field receives from 150 to 200 per cent; the series may be repeated after from two to three months. Technic: 180 kv., 0.5 mm. Cu + 1 mm. Al. Each series takes any length of time from 14 to 25 days. The Holfelder technic is used. Twenty-one cases have been treated according to this method during the last three years. Three patients with glioblastoma responded well at least temporarily. One out of five cases of medullary blastoma is free from symptoms. Five cases of astrocytoma are all well and

have lived now for an average of 21 months without symptoms. One case of glioma lives and has been well for 28 months. A second case died 27 months after the treatment in another hospital. Two patients with Lindau tumors were benefited by radiation therapy. In conclusion, the author states that no injurious effect of these high doses has been observed so far but admits that it takes a longer period of observation to come to a final decision.

ERNST A. POHLE, M.D., Ph.D.

BRONCHIECTASIS

Factors Causing Bronchiectasis: Their Clinical Application to Diagnosis and Treatment. W. P. Warner. Jour. Am. Med. Assn., Nov. 23, 1935, **105,** 1666–1670.

Bronchiectasis may be defined as a condition in which the bronchial tubes are dilated beyond their normal size. The pathologic process present practically always produces symptoms, the most common being chronic cough and sputum. The frequency of an acute respiratory disease preceding the bronchiectasis and the character of the general and local symptoms during the course of the disease strongly suggest infection as the important etiologic factor. In 59 per cent of 110 cases studied, bronchiectasis began with a known illness: pneumonia 30 per cent; lung abscess 12 per cent; influenza 5 per cent; whooping cough 4 per cent; "acute bronchitis" 3 per cent; measles 2 per cent; bronchiogenic carcinoma 2 per cent; foreign body 1 per cent. In 41 per cent the onset was insidious; there was no history of any acute respiratory infection immediately preceding the onset of bronchiectasis.

Bronchiectasis may occur without either fibrosis of the lung or pleural adhesions being present. The most marked and consistent pathologic finding is chronic inflammation of the bronchial wall, often with complete destruction of the muscle and elastic tissue. The initial fault in bronchiectasis is damage and subsequent weakening of the bronchial wall, probably caused by a non-specific infection.

The forces causing physiologic dilatation acting on a bronchus which has lost much of its elastic and muscle tissue will cause a greater dilatation than normal and the bronchus will not return to normal since its power of contraction is diminished because of the loss of elastic and muscle tissue in its wall. Added factors are atelectasis of the parenchyma, fibrosis of the parenchyma, and central bronchial obstruction, the latter rare in his experience.

It is extremely difficult to be sure that bronchiectasis is congenital unless it is found in a fetus or new-born baby.

The plain roentgenogram of the chest is usually negative or some thickening of the descending bronchial trunks may be observed. When certain secondary changes, such as chronic bronchopneumonia and fibrosis, occur in the parenchyma, roentgen evidence becomes of value. If lobar atelectasis occurs in bronchiectasis, a triangular basal shadow is observed, which is diagnostic of this disease. These represent a shrunken lobe containing bronchiectatic bronchi in his experience. The other plain x-ray film that is diagnostic of bronchiectasis is seen in massive atelectatic bronchiectasis, characterized by thin whorl-like shadows present from apex to base, with the mediastinum shifted to the affected side. Roentgen examination after injection into the bronchial tree of a radiopaque oil is the important diagnostic procedure to prove or disprove the presence of bronchiectasis.

The prognosis varies tremendously with the individual case, from one with disease rapidly progressing to a fatal termination, to one with practically no progression or disability.

CHARLES G. SUTHERLAND, M.B. (Tor.)

CANCER (DIAGNOSIS)

Primary Esophageal Carcinoma, with Especial Reference to a Non-stenosing Variety: A Clinicopathologic Study Based on 108 Necropsies. Robert W. Mathews and Truman G. Schnabel. Jour. Am. Med. Assn. Nov. 16, 1935, **105,** 1591–1595.

This is a clinicopathologic study based on 108 necropsies. Of these 108 cases, 22 (20.3 per cent) exhibited a non-stenosing variety of lesion, and in 86 the lesion was obstructive. Among the number with obstructive tumors, 5.8 per cent were women, and among the number with the non-obstructive variety of the disease, 13.6 per cent were women.

The three gross anatomic types of esophageal carcinoma found at postmortem examination were:

First, a large fungating carcinoma which protruded into the lumen, producing obstruction with dilatation proximal to the newgrowth. This type was responsible for the well known clinical syndrome of obstruction.

Second, an annular type, often partially or completely surrounding the lumen of the esophagus, extending outward and adhering to adjacent structures but not encroaching on the lumen. This type was ordinarily non-stenosing but produced dysphagia in some instances by reason of the esophagus being anchored (as often occurs in this type) at an unusual point or points. The mucosa often appeared grossly to be intact.

Third, the ulcerating type, with no narrowing of the lumen, usually with dilatation of the esophagus. This variety was non-stenosing.

Dysphagia was distinguished by its relative infrequency in the non-stenosing group, whereas in the stenosing group it was the dominant symptom.

CHARLES G. SUTHERLAND, M.B. (Tor.)

The Importance of Radiation Therapy Institutions in the Control of Cancer. Henry Schmitz. Minnesota Med., February, 1936, **19,** 88–91.

The author discusses the technical requirements for radiation therapy and the economic problem involved in supplying adequate equipment for the treatment of the 150,000 new cases of cancer diagnosed yearly in the United States. He concludes that 440 stations, supplied with 4 grams of radium element, would be sufficient. They could be established at a cost of

$88,000,000, not counting the cost of shielding and application equipment. Similar reasoning applied to 800,000-volt roentgen installations reveals that 104 stations at a total outlay of from $5,200,000 to $6,240,000 could meet all requirements for distant radiation therapy.

WILLIAM H. GILLENTINE, M.D.

CANCER (THERAPY)

Adenocarcinoma of the Oral Cavity. William L. Watson. Am. Jour. Roentgenol. and Rad. Ther., July, 1935, **34**, 53–62.

A series of 41 cases of intra-oral adenocarcinoma is studied in detail from a clinical point of view. These tumors are, in the majority of instances, derived from the minor salivary glands of the oral cavity but may arise from aberrant thyroid tissue or from mucous glands. The micropathology is only fairly constant, but the gross appearance of these tumors is diagnostic.

Clinically, these growths have a marked tendency to local recurrence, bone invasion, and widespread metastasis by way of the blood or lymph stream.

The radiosensitivity of these growths could not be definitely forecast by the microscopic picture, but clinically with one or two exceptions this group was quite radioresistant.

Present treatment is by a combination of external and interstitial irradiation followed by cautery excision.

The prognosis is poor, although many patients have a history of tumor presence for years before and after treatment.

S. M. ATKINS, M.D.

Modern Concepts of Roentgen Therapy in Cancer. W. Edward Chamberlain. Jour. Am. Med. Assn., Dec. 7, 1935, **105**, 1817–1820.

Most radiologists now recognize the fact that the voltage factor, long believed to be the most important, was actually one of the least important factors changed in the period from 1918 to 1928. In that period the real foundations for present roentgen therapy were laid. The physicist, with accurate methods of measurement under standardizable and reproducible conditions made it possible for physicians in various parts of the world to describe their dosage and quality factors in terms of the centimeter-gram-second system of international physical units. The research biologist followed with scientific data regarding the effects of measured amounts and specified qualities of x-rays on standardized biologic material.

The scientific roentgenologist of to-day recognizes certain limitations inherent in his method, tolerance of normal tissues, complete ridding of the patient of tumor cells, and other seemingly uncontrollable factors, but in spite of this roentgen therapy is being used more extensively now than at any previous time. Recent advances have been: (1) new knowledge of the nature and degree of skin tolerance and the recovery of the skin after irradiation; (2) increasing knowledge of the relationship between the location, type, and microscopic appearance of the tumor and the most effective method of applying the irradiation; (3) increasing appreciation of the place of pre-operative irradiation, and (4) decreasing emphasis on post-operative irradiation.

There is no physical basis for undertaking to treat patients with costly and troublesome million-volt x-ray apparatus. X-ray beams generated at voltages of a million or so ionize the atoms in the irradiated tissue according to a definitely different pattern. Irradiation at "supervoltages" includes bombardment of the tissues with neutrons, highly penetrating particles which are practically absent from conventional present-day x-ray beams. The question as to whether gamma rays are superior to x-rays for the treatment of cancer must remain for the present unanswered. So also must the question as to whether or not surgery can prevent the late recurrences of tumors that have apparently completely regressed.

To-day the radiologist and the surgeon stand face to face, each in need of the other's help, each ready to do his proper share of the work of combating cancer.

CHARLES G. SUTHERLAND, M.B. (Tor.)

Radiation Therapy of Tongue Carcinoma. R. A. Gardner. British Med. Jour., Dec. 7, 1935, No. 3909, 1090–1092.

Carcinoma of the tongue occurs in a site where extensive removal of tissue is mutilating, and, while treatment should be adequate, an effort should be made to conserve as much normal tissue as may be possible. Irradiation therapy of this condition is based on the differential destructive action on undifferentiated cells undergoing mitosis and on the surrounding normal tissue.

The author believes that carcinoma of the tongue may be cured by adequate irradiation as long as the disease is localized and has not extended to the regional lymphatics. This should be possible without any loss of normal tissue.

The anatomy of the tongue consists of two longitudinal muscular bundles which are joined medially by a fibrous septum. The lingual covering is squamous epithelium. The lymphatic drainage of the anterior portion of the tongue is to the submental and the anterior cervical glands. From the lateral part drainage is to the submaxillary group and to the upper cervical glands. At the root of the tongue, median vessels pass through the muscles to end in the submaxillary groups.

Functionally, the tongue is concerned with speech and partly with taste. While the extent to which speech is impaired depends upon the extent of involvement, taste is not commonly affected in lingual carcinoma. However, because the salivary glands are radiosensitive, irradiation therapy does produce some dryness of the mouth in these patients. Recovery to some degree occurs in time.

The lesion involving the tongue is a squamous-celled carcinoma showing various degrees of differentiation. In the author's series of 17 biopsies, 11 showed marked differentiation and one case, moderate differentiation.

The remaining five cases were reported as squamous-celled carcinoma without amplification.

While the former opinion that biopsy was dangerous has been abandoned, the author prefers to use a small snare with a diathermic current of high periodicity to remove small portions of tissue from the growing edge. It is believed preferable to remove all infected teeth and to put the mouth in good condition before the implantation of radium or radon. However, the danger of the implantation of cancer cells into a socket from which a tooth has been recently extracted should not be forgotten.

The primary lesion of the tongue may be treated by one or more of several methods of irradiation. These methods are interstitial, surface, or distance technics of employing radium or radon, or by the use of roentgen rays from a greater or lesser distance. The interstitial methods are more commonly used. However, in the case of a small accessible lesion the surface form of application may be preferable. The essential difference between radon seeds and radium needles is that in the case of the seeds the intensity of irradiation is much greater at the beginning of the treatment than at the end while in the case of the radium needles a uniform intensity of irradiation is obtained throughout the entire treatment time. From a practicable viewpoint, however, if the total dose is correct, there is no disadvantage to this variation in intensity. Distance or "bomb" radium has not been found adaptable to the treatment of the primary lesion of the tongue.

In the interstitial method of radium application the entire volume of the tumor should be uniformly irradiated. The extent of the tumor should be determined as accurately as possible and the needles placed to irradiate the margins of the growth and the normal tissue in the vicinity for a safe distance. An approximation of the necessary dosage is mentioned by the author as 1 mg. of radium element per c.c. of tumor volume. In large tumors the central portion should be irradiated by placing the needles farther apart than at the margins. The author believes that if the radiation is uniformly distributed, it is better to overdose than underdose. The small central ulcer due to radium overdosage may be removed at a later period by diathermy. This is soon followed by the growth of epithelium over the defect. The author considers it advisable to pack the tongue away from the jaw in cases in which much radium is disposed on the lateral margin of the tongue. While lead has been used for this purpose, it is believed that the proper thickness of lead to completely absorb the rays is impracticable. In addition, the lead, under the influence of transmitted gamma radiation, emits a very caustic radiation at the surface in contact with the jaw.

The usual method of roentgen irradiation is used in the treatment of the primary lesion of carcinoma of the tongue only when radium treatment is impracticable. However, Chaoul, of Berlin, has employed a roentgen-ray tube operated at a very short distance from the lesion. The technic consists of the administration of about 400 r daily for about twenty days to a small field about two inches square. The advantage of this form of therapy is that the tumor is not injured as it is by the insertion of radium needles.

The therapy of involved glandular areas consists of ablation, radium implantation, roentgen irradiation, and radium irradiation from a distance. While ablation is accompanied by a heavy operative mortality rate, the method, if thorough, is considered as good as any other procedure. Radium implantation is considered a difficult method in which to secure uniform irradiation, and even hazardous in some cases. Roentgen irradiation and the use of radium at a distance in the form of the "bomb," or in the form of the collar of Columbia wax, is limited by the skin tolerance.

The author reviews the results of irradiation therapy which have been reported by other authors. In his own series of 32 cases of carcinoma of the tongue which he has treated by radium implantation to the tongue and x-ray therapy to the glandular areas, the author was able to trace 21 cases. In this group, 18 are known to be dead and three patients are living and apparently free of their disease.

J. N. Ané, M.D.

Irradiation in Carcinoma of the Lip. Ira I. Kaplan and Simon Krantz. Am. Jour. Roentgenol. and Rad. Ther., September, 1935, **34,** 381–385.

In irradiation treatment of this condition, the results obtained are as good as from surgery, even when compared to the results following the radical operation. Surgical and irradiation statistics are shown to justify the above conclusions.

Treatment is begun by external irradiation of both sides of the neck employing 200 kv. and 800 to 1,200 r to each side, with a daily dose of 200 r. The lesion is cross-fired by radium tubes filtered through 1 to 1.5 mm. of platinum held in a wax mold over the lip. The dosage is from 1,200 to 2,000 mg.-hr. For this, the patient is hospitalized for from three to five days. In from ten to fourteen days a typical radium membrane forms which is completely gone in from two to four weeks, leaving a white, soft scar.

In the presence of metastatic nodes, larger doses of roentgen rays or the radium bomb or interstitial irradiation is employed.

Five-year cures in those cases with no metastasis were over 90 per cent and over 50 per cent in those with metastases.

S. M. Atkins, M.D.

DIATHERMY

The Physical Characteristics of Diathermy and Short Wave Diathermy Machines. Allan Hemingway and K. W. Stenstrom. Jour. Am. Med. Assn., Nov. 2, 1935, **105,** 1424–1430.

An electric current produces heat when it passes through tissues, and this action has for a number of years been utilized by physicians for treatment of certain conditions. The apparatus used is referred to

as the diathermy machine. The most important feature of this machine is that it delivers the only type of current (high frequency) which can be passed safely through the body at high enough intensity to raise the temperature appreciably.

The authors discuss the two types of diathermy machines used at the present time, the spark gap diathermy machine and the vacuum tube diathermy machine. The technical terms commonly used are defined.

The newer method of heat therapy, namely, the short wave diathermy, is at present in an experimental stage. Much valuable research has been done to clarify the problems involved; at the same time, there are in the literature some very misleading statements in regard to the merits of this form of therapy. They recommend that, owing to the lack of knowledge of many phases of this work and the indications of dangerous possibilities, the newer machines be used with the utmost caution.

On the other hand, conventional diathermy is an old established form of therapy about which much is known that has proved to be of a definite clinical value.

CHARLES G. SUTHERLAND, M.B. (Tor.)

FRACTURES

Healing of the Newer Bumper Fractures of the Tibia. Walter G. Stern and Louis E. Papurt. Jour. Am. Med. Assn., Dec. 28, 1935, **105,** 2147–2150.

In "bumper fracture" of the mid-third of the tibia the fracture of both bones of the leg is so characteristic that an automobile accident as the causative agent can often be deduced from the roentgenographic appearance alone.

There is a severe comminution and splintering of the bone with many larger and smaller fragments, with long linear fracture lines running up and down the tibia and, in the center of the comminution, a diamond- or pyramid-shaped fragment out of the cortex, usually in the anterior surface and often lying free from the rest of the fragments. The injury of the soft parts is usually severe and the fracture is often compound.

Occasionally, injuries in mines from coal cars, falling rock and the like, produce similar fractures.

The authors emphasize the extreme slowness with which the "bumper fracture" unites, usually 16 weeks or longer after immobilization. The average healing time in a series of more than 100 cases was 6.2 months.

CHARLES G. SUTHERLAND, M.B. (Tor.)

Reversed Colles Fracture: Successful Reduction by Closed Method. John G. Raymer. Jour. Am. Med. Assn., Dec. 28, 1935, **105,** 2150.

Reverse Colles Fracture—A Plea for Closed Reduction. Ralph B. Bettman and William J. Tannenbaum. Jour. Am. Med. Assn., Dec. 28, 1935, **105,** 2151.

All of these authors present cases of successful reduction by the closed method. Raymer's contribution is in answer to the assertion of Webb and Sheinfeld that "no cases of successful reduction by the closed method have been reported in the literature."

Bettman and Tannenbaum report a case under treatment at the time the above-mentioned article appeared. Both recommend several attempts at closed reduction in a straight position or in a position of dorsiflexion under roentgenographic control before open reduction is decided upon.

CHARLES G. SUTHERLAND, M.B. (Tor.)

Fractures of the Carpal Scaphoid. D. W. Gordon Murray. Canadian Med. Assn. Jour., February, 1936, **34,** 180–182.

In a discussion of fractures of the carpal scaphoid, Murray points out the two usual types: (*a*) fracture through the articular surfaces in the region of the waist of the bone, and (*b*) fracture involving the tuberosity. Mechanisms of production are discussed and therapeutic principles outlined. Roentgenograms taken in the anteroposterior and oblique positions usually show the fracture. If, however, the scaphoid appears foreshortened, other plates should be made to show the bone in a transverse view as nearly as possible. At times the roentgenogram fails to show a fracture which may be obvious on plates taken a few weeks later. This is due to the subsequent rarefying osteitis. In neglected cases, with non-union, one must differentiate a bipartite bone. This anomaly tends to be bilateral, so that plates of both sides may clear up the diagnosis.

WILLIAM A. SODEMAN, M.D.

GALL BLADDER (NORMAL AND PATHOLOGIC)

Cholecystic Disease: A Comparison of the Clinical with the Cholecystographic Data Concerning 500 Patients Not Operated On. B. R. Kirklin and Thomas W. Blake. Jour Am. Med. Assn., Nov. 2, 1935, **105,** 1416–1419.

This presents a comparison of the clinical with the cholecystographic data concerning 500 patients not operated on. The reliability of cholecystographic data when subjected to the test of operation and pathologic examination has been proven repeatedly. Occasionally, however, the question as to patients not operated on is raised; the implication is that, as only those patients who give marked symptoms of disease of the biliary tract ordinarily are subjected to operation, the percentage of correct cholecystographic diagnoses may easily be high, but that, if all patients regardless of severity of symptoms were operated on, the record of cholecystography might be less brilliant. The records of the 500 patients examined both clinically and cholecystographically at the Clinic but not operated on were divided into 200 in which no shadow of dye had been discernible and a report of non-functioning gall bladder had been made; 100 in which the shadow of dye had been only faintly discernible and a report of poorly functioning gall bladder had been made, and 200 in which the cholecystographic response had been normal and was so reported. Clinical examinations had been made by consultants and their assistants in the various sections of the Clinic, and in most cases more than one consultant had seen the patient and had

participated in the diagnosis. Cholecystographic examinations had been made after oral administration of the dye, according to a rigid technic, and interpretations had been made alternately by four consultants in the Section on Roentgenology.

In 90.8 per cent of these cases the cholecystographic report was in consonance with the final clinical opinion, closely approximating the accuracy of cholecystography as proved by operation.

CHARLES G. SUTHERLAND, M.B. (Tor.)

GALLSTONES

The Roentgen Diagnosis of Gallstone Ileus. Ake Schele. Acta Radiologica, 1935, **16,** 456–460.

Four reported cases of gallstone ileus are reviewed, following which the author reports an additional case of his own, diagnosed by roentgenograms. This case showed fistulous communication between the gall bladder and the duodenum, with a foreign body in the upper part of the jejunum, causing proximal dilatation, including the stomach.

E. M. SHEBESTA, M.D.

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

Prolapsing Lesions of the Gastric Mucosa. Eugene P. Pendergrass and J. Robert Andrews. Am. Jour. Roentgenol. and Rad. Ther., September, 1935, **34,** 337–350.

Eight cases of prolapsing lesions of the gastric mucosa have been studied in the Hospital of the University of Pennsylvania since 1926. Seven of these cases were diagnosed correctly pre-operatively by roentgen examination, while no diagnosis was submitted in one case. Eight cases of a variety of other gastric and duodenal diseases were diagnosed incorrectly as prolapsing lesions. The essential diagnostic feature of these prolapsing lesions was the appearance of "a large negative filling defect of the pyloric end of the stomach which was movable and which could be pushed into the duodenum, where it formed a deformity of the cap." The appearance on the roentgenogram of these lesions is suggestive but not characteristic, as it is simulated by other conditions. When such a suggestive appearance is observed on the roentgenogram in the presence of a negative roentgenoscopic examination the diagnosis of a prolapsing lesion of the gastric mucosa should be held to be equivocal and the patient re-examined, giving special emphasis to the roentgenoscopic examination. No attempt at distinction between prolapsing hypertrophic gastric mucosa and prolapsing pedunculated polyp should be made roentgenologically, but the condition should be diagnosed merely as a prolapsing lesion of the gastric mucosa. The treatment of these lesions is entirely surgical. The diagnosis is of great importance because the lesions tend to ulcerate and bleed, with subsequent secondary anemia. Of great importance are the early recognition of prolapsing polyps and their resection, because they may be malignant. The roentgen examination of these patients, because there is no characteristic clinical syndrome, occupies the place of prime importance in the diagnosis of these obscure lesions.

S. M. ATKINS, M.D.

GROWTH

Growth, Normal and Abnormal. William Boyd. Jour. Am. Med. Assn., Nov. 9, 1935, **105,** 1520–1522.

Growth is the most fundamental of all biologic processes and one of the most mysterious. The cell units of the large animal are no bigger than those of the small one. When a cell divides into two the daughter cells are at first smaller; soon they attain the original size, but become no larger. Growth is gradual, but cell division is not gradual. It takes place suddenly and is completed in the space of an hour. The cells of an organ do not all divide at the same time. The cells that are not dividing are functioning; those which are dividing have no time for work. At a certain stage of development some cells, such as those of connective tissue, are capable of unlimited and inexhaustible growth, provided the environment is ideal, the supply of food is abundant, and the cells are not burdened with work. The power of growth varies at different age periods. It is enormously great in the early months of fetal life. This remarkable rate of growth is not necessarily dependent on conditions of intra-uterine life. At the end of the period of infancy there is a comparative rest in the motion of growth, a period of minimum rate of gain, rate of growth, and rate of heat production. Though growth ceases in adult life, the cells still retain their capacity for growth. Were it not so, repair would be impossible. Perhaps malignant neoplasia would also be impossible.

The control of growth is discussed in relation to the factors that govern and stimulate growth, embryonic tissue extract, thyroxine, the anterior pituitary growth-stimulating factor, and certain vitamins. Generally speaking, growth and specialization are mutually antagonistic. The great controller of growth is differentiation.

The best example of a vitamin-deficiency disease leading to stunting of growth is rickets, in which the lack of vitamin D interferes to such a degree with the development of cartilage into bone that the child for a time at least may be a rachitic dwarf. It is probable that the most important element in dwarfism is lack of the growth-stimulating hormone of the pituitary. Thyroid deficiency in early life is also associated with dwarfism, for the cretin is a dwarf physically as well as mentally. The cretin can be made to grow by anterior pituitary extract as well as by thyroxine. A form of lack of growth difficult to explain is that known as renal dwarfism. Achondroplasia affords another well-known example of stunted stature for which at present no explanation can be offered.

When fibrous tissue or other cells are destroyed, growth-stimulating substances are liberated, and it is the action of these which brings about the renewed growth and repair of tissue without which the surgeon's art would be impossible.

When tissue cells, particularly cells of embryonic tissue, are placed in a suitable culture medium which insures a continuous supply of food and growth-stimulating substances, they will grow and multiply far beyond the life span of the animal from which they were taken. When the tissue is removed from its environment, which apparently provides it with the stimulus to differentiate, it has no work to do and does not have to provide itself with food, so that it can devote all its energies to reproduction.

The resemblance between a malignant tumor and a tissue culture such as described is so evident that it does not need to be elaborated.

CHARLES G. SUTHERLAND, M.B. (Tor.)

GYNECOLOGY

Radiation Therapy of Pelvic and Abdominal Adhesions. A. Laquerrière. Strahlentherapie, 1936, **55**, 121.

In cases of pelvic and abdominal adhesions which do not respond to diathermy the author recommends roentgen therapy applied according to the following technic: 140–150 kv., 5–8 mm. Al, 200 r over an anterior and a posterior field, 600–800 r per field per series. This should not be repeated before an interval of several weeks has elapsed. The results in the author's clinic have been very encouraging. In acute cases, particularly in patients recovering from an operation in whom there is reason to expect adhesions, prophylactic roentgen therapy with small doses is recommended.

ERNST A. POHLE, M.D., Ph.D.

LEUKEMIA

Lymphocytic, Myelocytic and Monocytic Neoplasms: Roentgen Diagnosis and Treatment. Howard P. Doub and Frank W. Hartman. Jour. Am. Med. Assn., Sept. 21, 1935, **105**, 942–948.

This paper represents an attempt to gather and correlate some of the x-ray studies through a report of some of their own cases and the review of others from the literature.

Roentgen examination is indicated in all cases of lymphatic leukemia with pain or swelling over the bones and joints. The incidence of bone changes was, in order of frequency, femur, humerus, pelvis, metacarpals, ulna, and vertebræ. There may be elevation of the periosteum due to infiltration beneath the periosteum, and this is sometimes followed by osteosclerosis from proliferation of new bone. Extensive generalized osteoporosis may sometimes be present without localized areas of destruction. The most constant change noted was a rarified area near the end of the bone adjacent to the epiphyseal line together with elevation of the periosteum, or elongated localized leukemic deposits in the ends of the bones, with absorption of the bony cortex about these deposits. Mediastinal tumors in connection with lymphatic leukemia have frequently been reported. A number of cases of lymphatic leukemia associated with lymphosarcoma have been reported. The prognosis in lymphatic leukemia is uniformly bad but, in the chronic type, roentgen therapy may prolong life for a considerable period of time.

Roentgen examination of the bones reveal very few changes in myelogenous leukemia. In one reported case there was mottling of the upper portions of the femurs, with central punched-out lesions. Erosions of medullary bone were found in stages that could not be demonstrated roentgenologically. Changes shown by roentgen examinations are late changes. Roentgen therapy is the chief therapeutic agent for the control of this disease. Irradiation is usually applied over the long bones, vertebræ, ribs, and sternum in order to destroy the radiosensitive myeloid hyperplasia. A stage finally arrives in which all treatment is ineffectual.

Roentgen changes in chloroma are quite variable; marked destruction in the long bones with occasional bone proliferation, a large area of destruction in the vault of the skull underlying a soft tissue tumor, elevation of the periosteum over the long bones, parallel to the shaft or perpendicular striæ, often near the ends of the diaphyses have been observed. Practically all cases reported in the literature have ended fatally, with the exception of one patient who was living and well two and one-half years following roentgen therapy.

In certain atypical cases of generalized myeloid hyperplasia of the bone marrow and viscera in which the white blood count and differential count are practically normal, the roentgen changes are of considerable importance in the differential diagnosis. The bone changes may be either osteolytic or osteosclerotic. The osteolytic type may be mistaken for multiple myeloma or metastatic carcinoma. Single areas of osteolysis, multiple areas of bone absorption together with subperiosteal proliferation parallel to the shaft of the bone have been observed. Perpendicular striæ near the muscle and tendon attachment of numerous bones were seen, rarefaction around the distal ends of the long bones, with a generalized osteoporosis was another feature.

In the cranial bones there were multiple pin-point areas of decalcification; the lesions were osteoblastic in type in the spine and cases of generalized osteosclerosis indistinguishable from the osteoblastic type of metastatic carcinoma were reported. Therapy in this group of cases was of no avail.

Bone changes in Hodgkin's disease have been reported in from 10.7 to 34 per cent. The bones involved in the order of their frequency are: vertebræ, sternum, pelvis, femur, ribs, skull, humerus, scapula, and clavicle. Roentgen examination has disclosed both osteoclastic and osteoplastic lesions. In the spine the two types of lesion may be present in the same case, the discs being usually unaffected. The pelvic bones may show rather extensive osteolytic lesions with large, cyst-like areas interspersed with areas of eburnation. Lesions of the long bones are apt to begin in the proximal ends, osteolytic and osteoplastic lesions may be combined, and there may be periosteal thickening. The ribs show punched-out areas of bone

destruction. Lesions of the skull are apt to be osteoclastic. Roentgen therapy is the most effective agent in the treatment of Hodgkin's disease.

Bone involvement in lymphosarcoma is not so common as it is in Hodgkin's disease. The roentgen changes are similar, however.

No definite changes in bone have been observed in monocytic leukemia.

In the differential diagnosis sympathetic neuroblastoma, metastatic carcinoma, multiple myeloma, osteogenic sarcoma, xanthomatosis, Gaucher's disease, Albers-Schönberg's disease, and bone infections must be considered.

The periosteal changes in conjunction with the peculiar moth-eaten areas of erosion at the ends of the diaphyses—usually at the proximal ends along the medial border—are changes that are rather uncommon in other diseases. When these are associated with the pin-point areas of decalcification in the flat bones, one should suspect some myeloid or lymphoid neoplastic condition.

CHARLES G. SUTHERLAND, M.B. (Tor.)

Bone Changes of Leukemia in Children. James M. Baty and Edward C. Vogt. Am. Jour. Roentgenol. and Rad. Ther., September, 1935, **34,** 310–313.

The bones of 43 children with leukemia were studied roentgenographically. In 70 per cent of the patients, there was a narrow zone of diminished density proximal to the metaphyses of the long bones. There was generalized osteoporosis in two patients and a slight periosteal elevation in two others.

S. M. ATKINS, M.D.

THE LIVER

Effect of Roentgen Rays on the Glutathion of the Liver. A. O. Nathanson and G. A. Tscherkes. Strahlentherapie, 1936, **55,** 96.

The liver of rats or the entire animals were exposed to roentgen rays (170 kv., 0.5 mm. Cu + 2.0 mm. Al; 100–200 per cent H.E.D.). As a rule the glutathion content of the liver is increased following irradiation; this affects equally the oxidized and the reduced glutathion after doses of 200 per cent H.E.D. The oxidized glutathion is considerably increased following a dose of 100 per cent H.E.D.; at the same time the reduced glutathion may not show any changes. The fluctuations in the glutathion content of the liver are regarded by the author as the result of a systemic effect of roentgen rays.

ERNST A. POHLE, M.D., Ph.D.

THE LUNGS

Lobar Collapse in Children. Gladys L. Boyd. Jour. Am. Med. Assn., Dec. 7, 1935, **105,** 1832–1835.

The collapse of one lobe of the lung may take place in various locations and from several causes. Its actual occurrence is so restricted to the atelectasis of a lower lobe, characterized radiologically by basilar triangular shadow, that its discussion is practically limited to the study of the latter condition. Such collapse is usually associated with bronchiectasis. Lobar atelectasis is the result of infection or injury of the bronchial wall, with secretion and consequent plugging of the bronchioles.

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Pulmonary Changes Associated with Upper Respiratory Tract Abnormalities and Diseases. T. Gage Clement. Am. Jour. Roentgenol. and Rad. Ther., September, 1935, **34,** 364–373.

Conditions of the mastoids, nose, and throat may cause lung pathology and symptoms as well as may sinus infection. The roentgen changes of the lungs consist of a prominence of the hila and lung markings which are probably due to peribronchial and perivascular thickening in that the prominence persists when the causative factor is removed and the symptoms are absent.

Amongst the causes given by the author, with report of representative cases, were: abnormal nasal septum, mastoiditis, tonsillitis, sinusitis and, in some, involvement of more than one of these regions.

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Primary Carcinoma of the Lung. Editorial. Jour. Am. Med. Assn., Sept. 7, 1935, **105,** 802, 803.

The older writers divided their cases into tumors arising (*a*) from the epithelium lining the bronchi, (*b*) from the epithelium that is said to line the pulmonary alveoli, and (*c*) from the epithelial cells that form the mucous glands. Fried concluded, after reviewing the subject recently, that all primary lung carcinomas originate from the mucous membrane lining the bronchi. Olson likewise believes that if non-bronchiogenic carcinomas of the lung exist they are rare. He classified histologically into three main groups the 69 cases in his series that came to necropsy: squamous-cell carcinomas, adenocarcinomas and undifferentiated carcinomas. The squamous-cell carcinomas comprised 42 per cent of the cases, and 28 per cent of them showed the characteristic epithelial "pearl" formation. These tumors were single, gray or white solid masses in 75 per cent of the cases. Multiple masses in one lung were found in only 8 per cent. Areas of tumor necrosis were relatively infrequent. The adenocarcinomas comprised 24 per cent of the entire series. Their chief distinguishing feature was the secretion of mucous and the irresemblance to bronchial mucous glands. Since more than half of them showed definite secretory function, this group was subdivided into mucinous and non-mucinous adenocarcinomas. Grossly, the adenocarcinomas usually appeared as gray, firm, scirrhous tumors with scattered areas of softer yellowish tissue showing visible mucous. Necrosis was uncommon in this group of tumors.

The undifferentiated group of lung cancers was composed of "small cell tumors," which in the past were

often called sarcomas. Of the total series of 69 cases, 33 per cent were of the undifferentiated small cell type. The primary tumor in this group was a mass at the hilus in 65 per cent of the cases, while a secondary or primary bronchus was involved or occluded in 100 per cent. Only 43 per cent of them could be localized by lobes. The entire left lung was infiltrated in 9 per cent and the entire right lung in 4 per cent. The primary bronchi were involved in more than twice as many cases as in either of the other two types of tumors. Grossly, the undifferentiated carcinomas varied from a soft pink mass to hemorrhagic, necrotic, and sometimes caseous masses. Necrosis and hemorrhage were prominent in this group.

Metastases from carcinoma of the lung have been reported in practically every part of the body. The undifferentiated small-cell type of tumor showed the most vigorous tendency to metastasize.

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OSTEOMYELITIS

Osteomyelitis in Infancy. William T. Green. Jour. Am. Med. Assn., Dec. 7, 1935, **105**, 1835–1839.

Osteomyelitis of infancy is a disease more frequently due to *Streptococcus hæmolyticus* in which, if the child survives the acute infection, the prognosis for complete and rapid recovery is excellent.

The systemic manifestations are frequently severe and are usually noted before the presence of a local lesion is appreciated. Local sensitivity is soon evident, swelling may be noted and soon becomes marked, and it is frequently so diffuse as to be of little aid in localizing the site of the lesion. Roentgenograms do not demonstrate the lesion until from seven to twelve days after the onset. They may be helpful in demonstrating the presence of scurvy, syphilis, or an osteomyelitic lesion of longer duration than the history suggests. The visualization of the soft tissues may be helpful. Roentgenograms taken to observe the course of the disease frequently exhibit extensive destruction with involucrum; rapid healing without sequestration is a frequent end-result.

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PEPTIC ULCER

Duodenal Ulcer with Rupture on the Fourth Day of Life. Frank Seinsheimer. Jour. Am. Med. Assn., Sept. 14, 1935, **105**, 875, 876.

The author, in reporting a case of perforated duodenal ulcer occurring on the fourth day of life, stated that a review of the literature revealed reports of twelve such cases since 1868. In his case, a baby boy, delivered by Cesarean section in the eighth month of pregnancy, the mother having had a hemorrhage from a placenta prævia centralis, after persistent forceful regurgitation of the feedings, suddenly developed symptoms of shock. Shortly afterward the abdomen became distended and in a few hours the scrotum and abdominal wall became edematous and discolored. Physical signs of fluid developed in the abdomen, and the diagnosis was made of a ruptured hollow viscus. The baby died shortly thereafter and necropsy revealed a small perforating duodenal ulcer, surrounded by a small circumscribed, reddened area, which was not indurated. Microscopic examination of the tissue adjacent to the perforation showed no cellular evidence of inflammation.

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RADIATION, PHYSICS OF

Action of Radon on Polymethylenes. G. B. Heisig. Jour. Phys. Chem., November, 1935, **39**, 1067–1073. (Reprinted by permission from Science Abstracts, Sect. A, Physics, Jan. 25, 1936, **39**, 35.)

Pure cyclopentane and cyclopentene are prepared and the vapor pressures determined at several temperatures. The action of radon on these compounds is studied. The $-M/N$ values are in agreement with the heats of formation and with $\Delta(H_2 + CH_4)100/-\Delta HC$.

Reduction of Ferric Chloride by Alpha, Beta, and Gamma Rays. G. W. Spicer. Trans. of Faraday Soc., December, 1935, **31**, 1706–1710. (Reprinted by permission from Science Abstracts, Sect. A, Physics, Jan. 25, 1936, **39**, 35.)

The following cases of the irradiation of ferric chloride are studied: Using α-rays (*a*) aqueous ferric chloride solution, (*b*) anhydrous ethereal solution, (*c*) solid anhydrous ferric chloride. Using β- and γ-rays (*d*) aqueous ferric chloride solution, (*e*) anhydrous ethereal solution. Complete reduction is found to occur in the instances of (*a*), (*b*), and (*e*). In case (*c*), although reduction occurs it is apparently incomplete, a yield of chlorine of 1.002 mg. being obtained out of a possible total of 3.66 mg. In this case, too, it is possible that reduction may be complete in the thin layer through which the α-rays penetrate. In case (*d*) no reduction can be detected, and this is, therefore, the only exception to reduction in the series studied.